Emerging Wireless/Mobile Technologies:
Patents & Standards for
4G LTE, Cognitive Radios, M2M

1Q. 2011

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I. LTE-Advanced

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LTE-Advanced Patent Landscape

LTE-Advanced is one of major technology for 4G (IMT-Advanced) standards. LTE patent portfolios are researched among US market leaders. To find the key IPR holders for the LTE-Advanced patents, a keyword search of the USPTO patent data base has been performed.

Total of 317 published patent applications are identified as of Feb. 28, 2011. Qualcomm is the leader followed by InterDigital, AT&T, Samsung, RIM, LG, and Motorola as of Feb. 28, 2011.
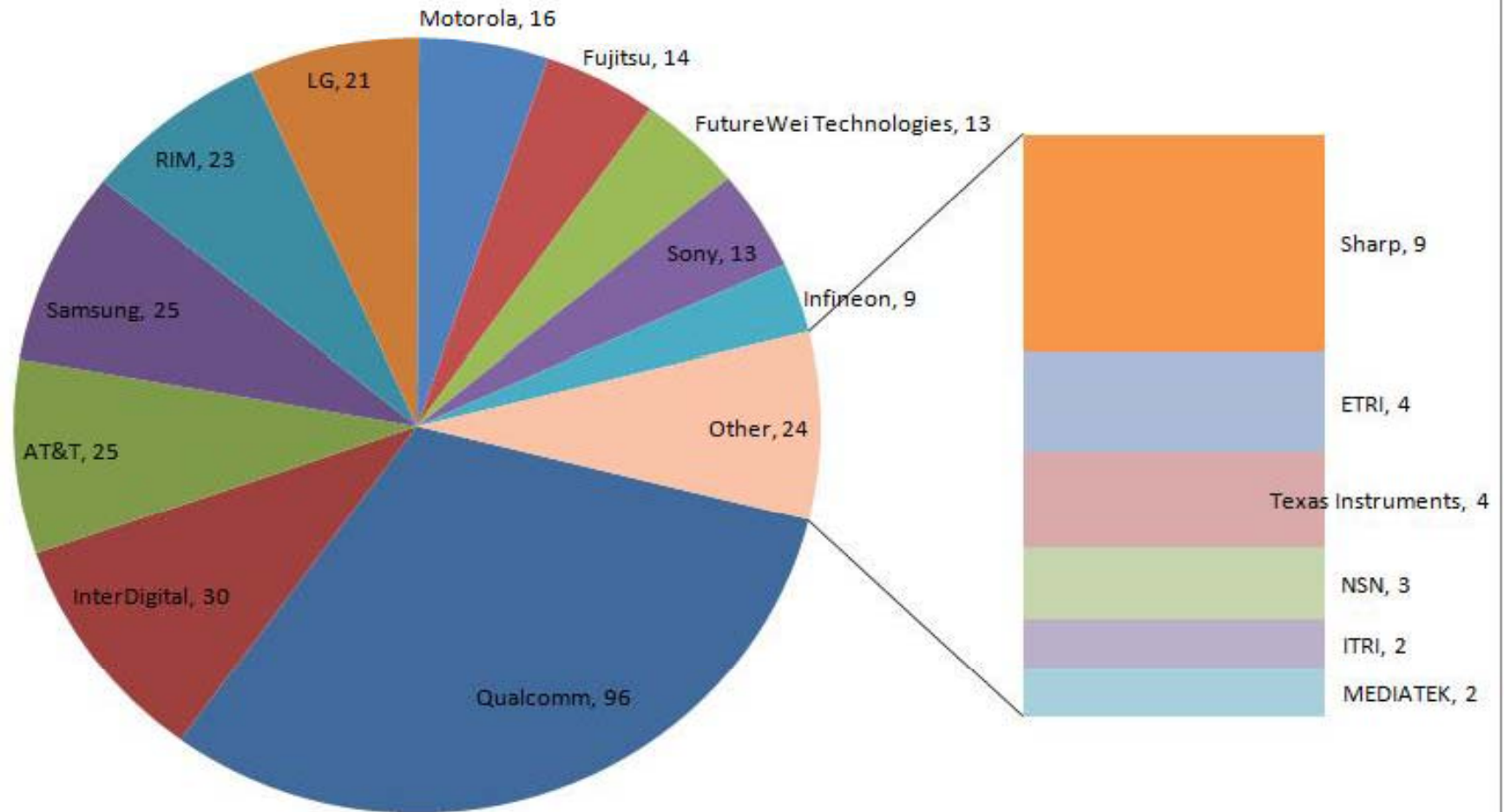
The distribution of LTE-Advanced patents among the key technologies in standard specifications is as follows:
Carrier Aggregation (17%), HetNet (12%), Relay (53%), SON (11%), and SU-MIMO (7%).

Ref. Figure 1.

Fig.1 LTE-Advanced Patent Landscape

LTE-Advanced US Patent Landscape by Assignee

Motorola, 16
Fujitsu, 14
FutureWei Technologies, 13
Sony, 13
Infineon, 9
Other, 24
Qualcomm, 96
InterDigital, 30
AT&T, 25
Samsung, 25
RIM, 23
LG, 21

Sharp, 9
ETRI, 4
Texas Instruments, 4
NSN, 3
ITRI, 2
MEDIATEK, 2

Cognitive Radios for Femtocell

The femtocell unit incorporates the functionality of a typical base station (eNodeB in LTE). A femtocell unit looks like a WiFi access point. However, it also includes all the core network elements.

In 3GPP terms, LTE femtocells are called Home Node B's for HSPA (HNB) and Home eNode B's for LTE (HeNB).

Femtocells must be able to search the radio channel and estimate which resources are free among the available ones in order to avoid cross-layer and co-layer interference.

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Cognitive Radios for SON

The self-organizing network (SON) aims to leapfrog to a higher level automated operation in mobile networks. SON is part of the move to the 4G LTE. The main functionality of SON includes: self-configuration, self-optimization and self-healing.

LTE SON is an approach of cognitive radio aspects from the cellular networks perspective.

Femtocell based SON must be aware of the presence of neighboring cells and their power and spectrum allocation in order to maintain the femtocell coverage and avoid interference.

Ref. Figure 2.

Fig. 2 Cognitive Radios for 4G LTE:
Patent Case Study

US20090XXXX

High quality communications among a diverse set of cognitive radio (CR) nodes is permitted while minimizing interference to primary and other secondary users by employing Dynamic Spectrum Access (DSA) in a Dynamic Cellular Cognitive System (DCCS). Diverse device types interoperate, cooperate, and communicate with high spectrum efficiency and do not require infrastructure to form the network. The dynamic cellular cognitive system can expand to a wider geographical distribution via linking to existing infrastructure.
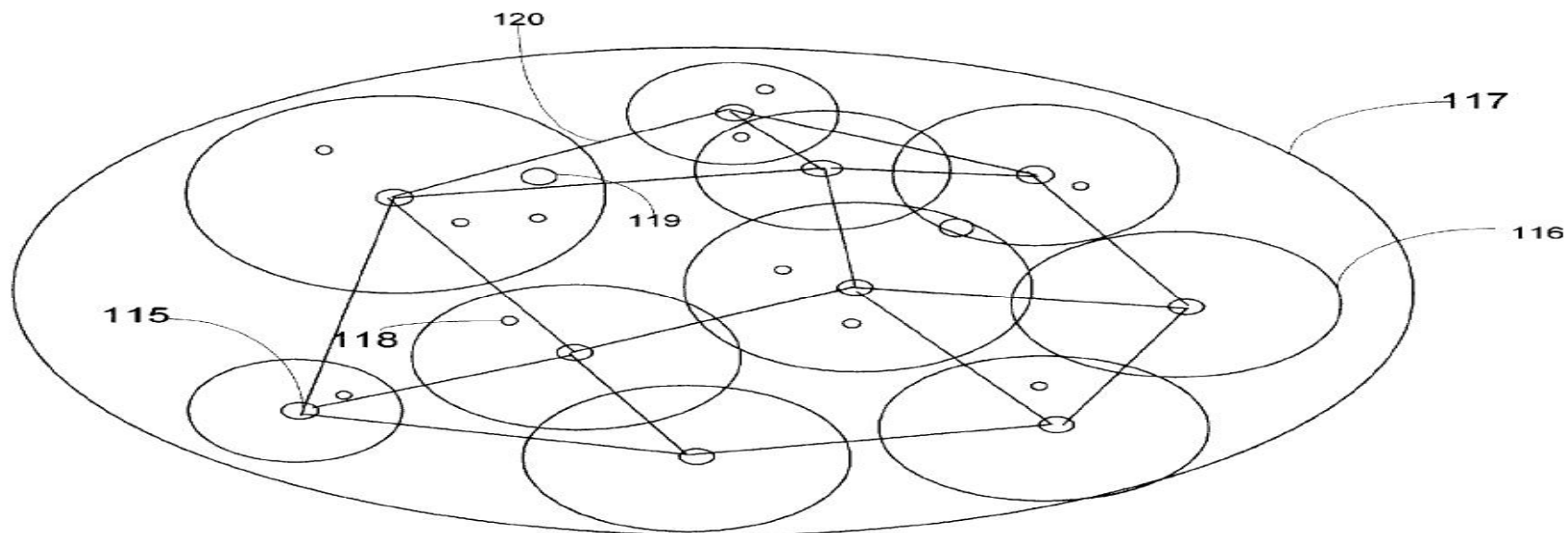
II. Cognitive Radios for TVWS

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Cognitive radios are the essential enabler for using a whitespace in TV spectrum bandwidth by finding free spectrum in the TV band. The technologies for the cognitive radios over TV white space are under standardization by IEEE 802.11af and 802.22.
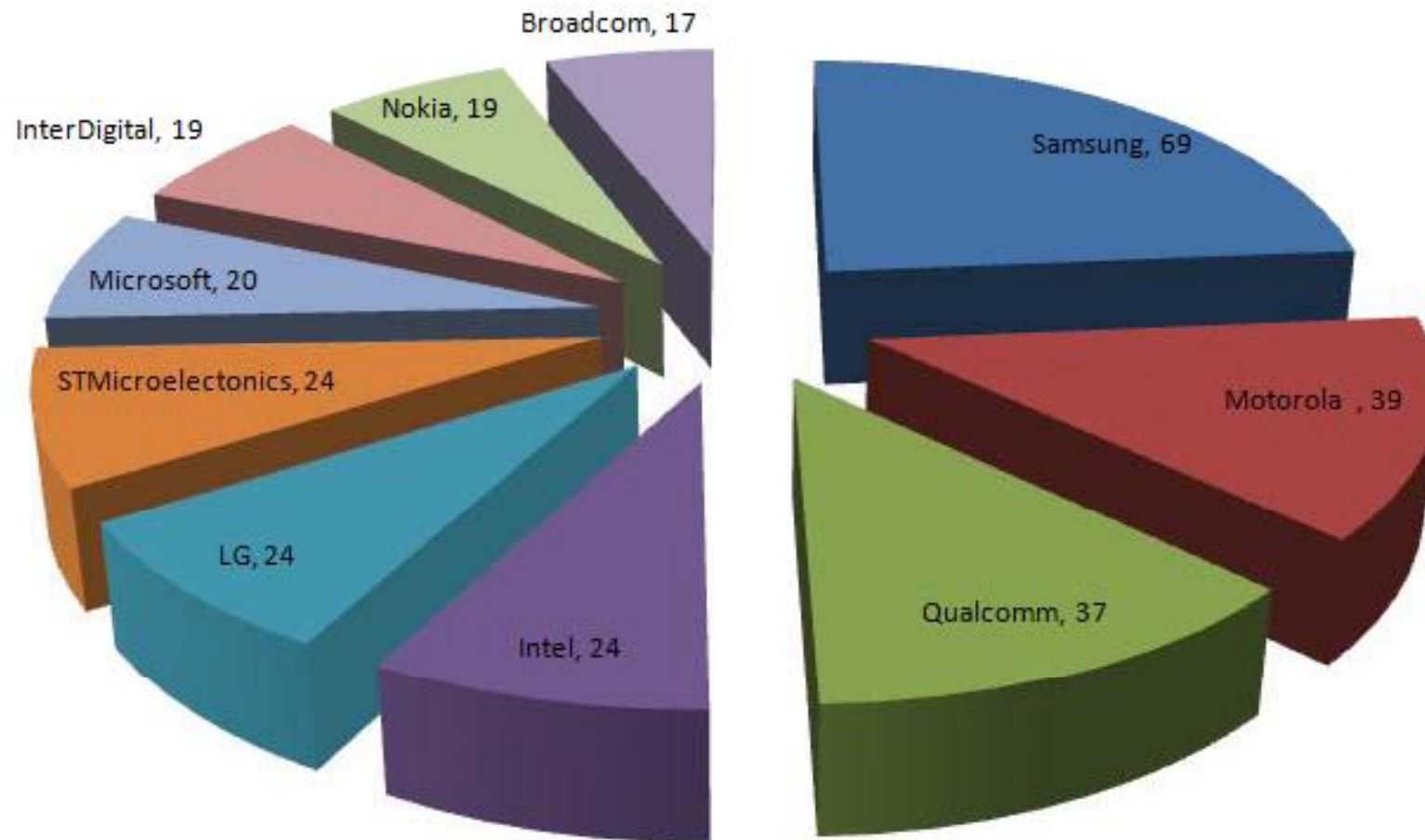
To find the technology innovation status of cognitive radio over TVWS, a keyword search of the USPTO patent data base has been performed. Total of 701 cognitive radio over TVWS related patents (158 issued patents and 543 published applications) in the US as of Sept. 30 2010 are identified.

Samsung Electronics was the leader in the cognitive radio over TVWS technology innovations followed by Motorola, and Qualcomm.

Ref. Figure 3.

Fig. 3 Cognitive Radios for TVWS Patent Landscape

Cognitive Radio over TVWS Top 10 Assigness

- Broadcom, 17
- Nokia, 19
- InterDigital, 19
- Microsoft, 20
- STMicroelectonics, 24
- LG, 24
- Intel, 24
- Samsung, 69
- Motorola, 39
- Qualcomm, 37

III. M2M
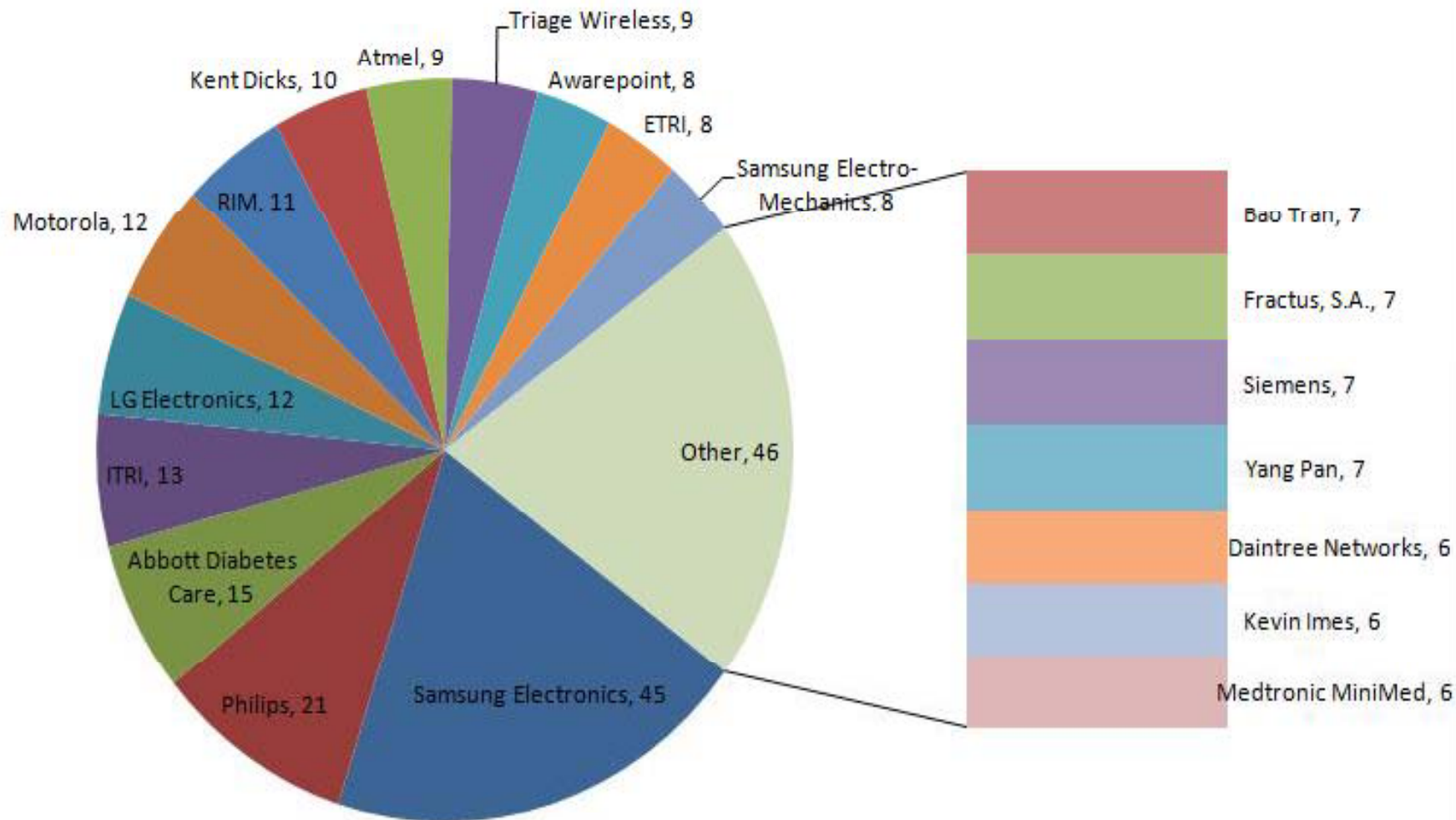
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Zigbee for M2M Patent Landscape

ZigBee is a low-cost, low-power, wireless mesh networking standard based on the IEEE 802.15.4-2003 for Wireless Personal Area Networks. Zigbee is one of key enableing technologies for M2M (Machine-to-Machine) applications: smart grids. connected home, building automation, mobile helath, security, and automatic control.

To find the key IPR holders for zigbee for M2M patents, a keyword search of the USPTO patent data base has been performed. Total of 864 patents (727 published patent applications) are identified as of Feb. 28, 2011. Samsung Electronics is the leader followed by Philips, Abbott Diabetes Care, ITRI, LG Electronics, Motorola, and RIM.

Ref. Figure 4.

Fig. 4 Zigbee for M2M Patent Landscape

Zigbee for M2M Patents Top 20 Assignees

- Triage Wireless, 9
- Awarepoint, 8
- ETRI, 8
- Atmel, 9
- Kent Dicks, 10
- Samsung Electro-Mechanics, 8
- RIM, 11
- Motorola, 12
- Other, 46
- LG Electronics, 12
- ITRI, 13
- Abbott Diabetes Care, 15
- Philips, 21
- Samsung Electronics, 45

- Bao Tran, 7
- Fractus, S.A., 7
- Siemens, 7
- Yang Pan, 7
- Daintree Networks, 6
- Kevin Imes, 6
- Medtronic MiniMed, 6

Gigabit WiFi

60 GHz unlicensed band wireless systems, which can carry Gbps of data, enable several new applications: high definition video streaming wireless in real time, high speed wireless gaming, and wireless docking and connection to displays.

IEEE 802.11ad was formed in January 2009 to make industry standard for 60 GHz wireless systems as an amendment to the existing IEEE 802.11-2007 (modifications to the 802.11 PHY and the 802.11 MAC).

To find the technology innovation status of 60 GHz wireless systems, a keyword search of the USPTO patent data base has been performed. Total of 177 60 GHz wireless systems patents (38 issued patents and 139 published applications) in the US as of Feb. 28 2011 are identified.

Broadcom was the leader in the 60 GHz wireless system technology innovations followed by Samsung Electronics, Qualcomm, Intel, Nokia, NICT, and Toshiba.
Ref. Figure 5.

Fig. 5 Gigabit WLAN Patent Landscape

60 GHz WLAN Patent Landscape

NFC
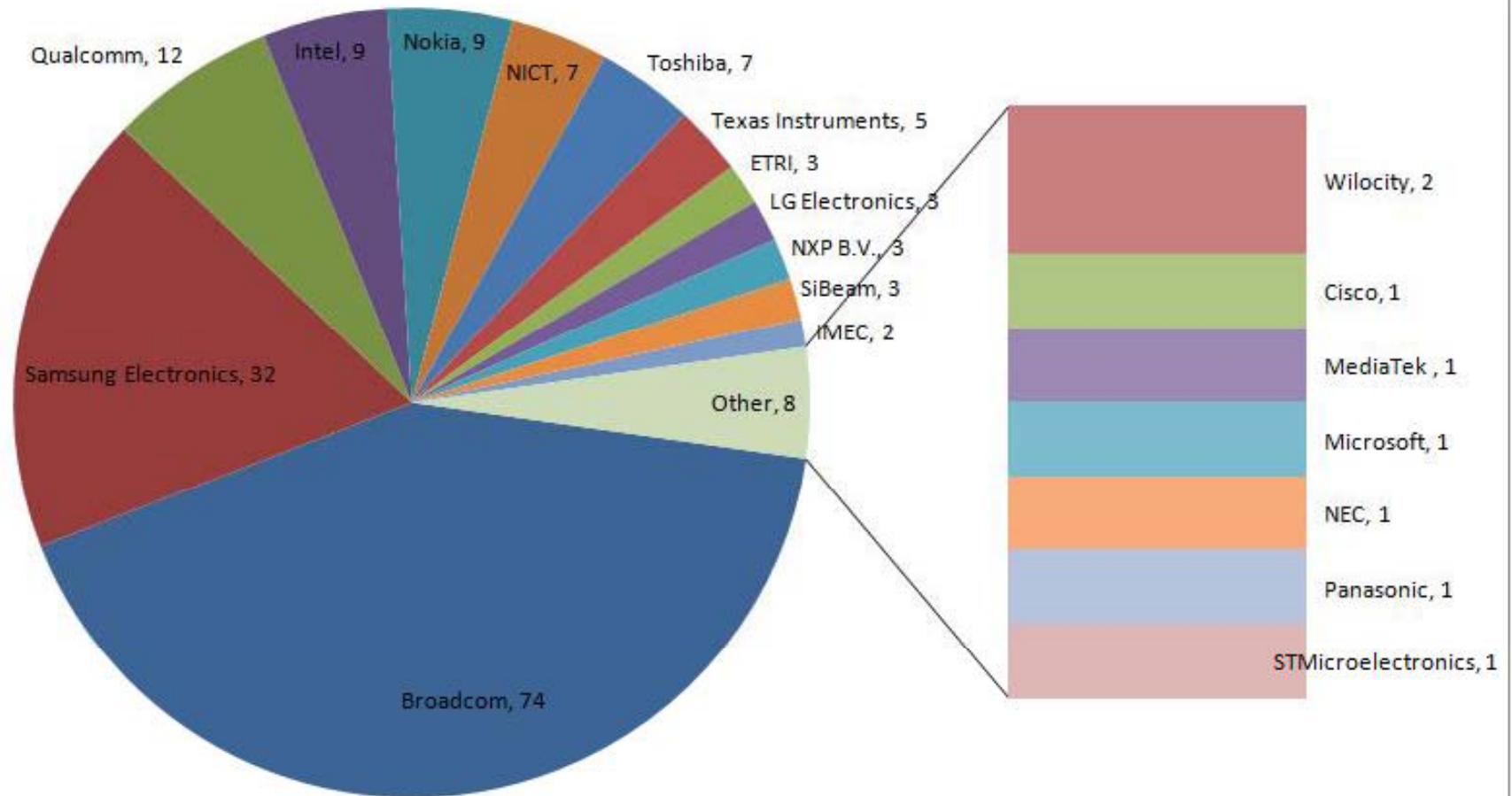
NFC (Near field communication) is a short-range wireless technology for mobile transaction applications. Industry standard for NFC technology is under development by the NFC Forum:
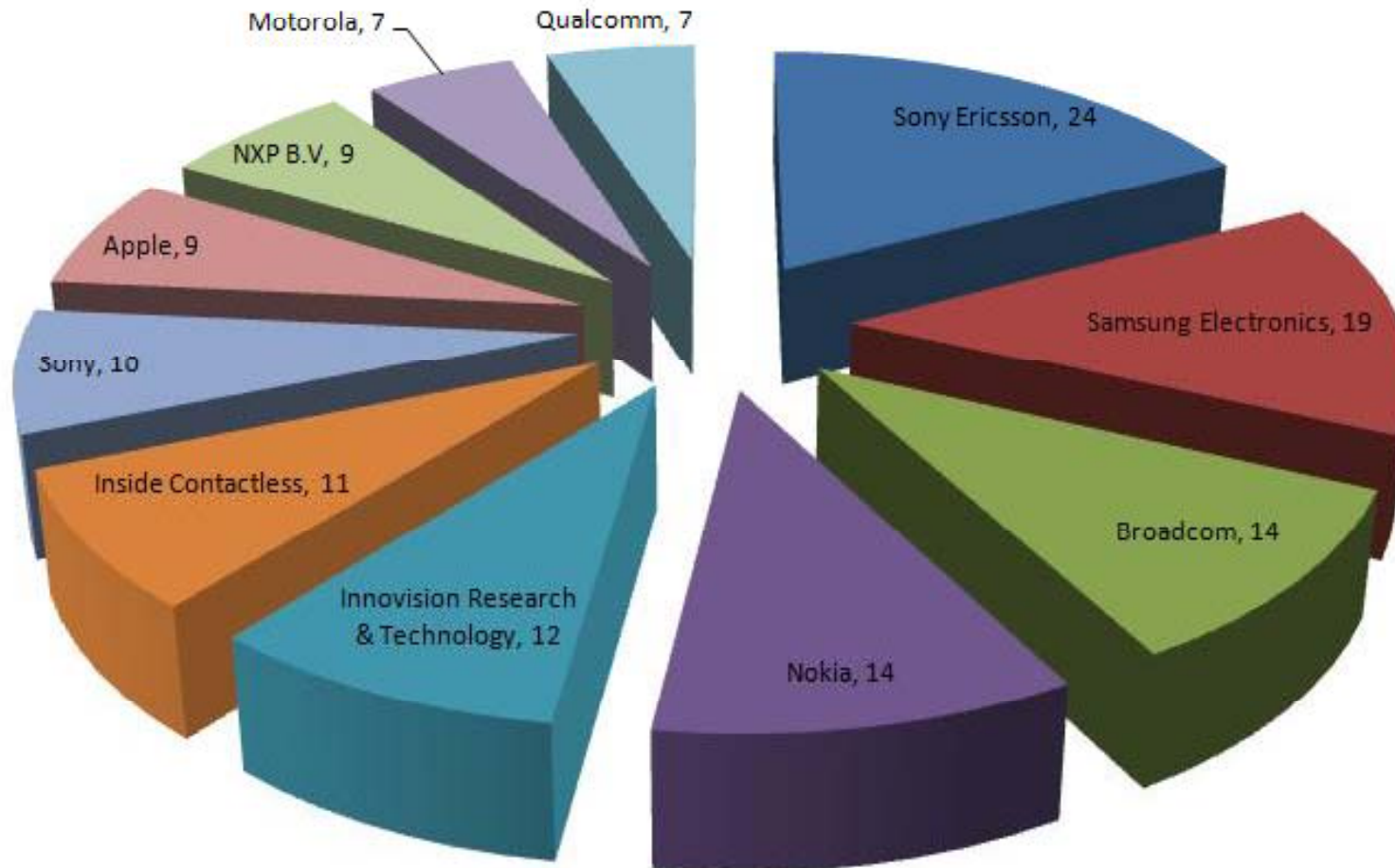
Data Exchange Format Technical Specification, NFC Forum Tag Type Technical Specifications, Record Type Definition Technical Specifications, Reference Application Technical Specifications, Personal Health Device Communications Technical Specification, Protocol Technical Specifications, NFC Logical Link Control Protocol (LLCP) version 1.1 (includes Service Discovery Protocol Technical Specification), NFC IP Binding Technical Specification, NFC OBEX Binding Technical Specification, Requirements Approved, NFC RF Analogue Technical Specification, NFC Simple NDEF Exchange Protocol (SNEP) Technical Specification, NFC Device Internal Technical Specifications, NFC Controller Interface (NCI) Technical Specification.

To find the key IPR holders for NFC patents, a keyword search of the USPTO patent data base has been performed. Total of 399 patents (280 published patent applications) are identified as of Feb. 28, 2011. Sony Ericsson is the leader followed by Samsung Electronics, Nokia, Broadcom, Innovision Research & Technology, Inside Contactless, Sony, Apple, and NXP B.V.

Ref. Figure 6.

Fig. 6 NFC Patent Landscape

NFC US Patent Top 10 Assignees

- Motorola, 7
- Qualcomm, 7
- Sony Ericsson, 24
- NXP B.V, 9
- Samsung Electronics, 19
- Apple, 9
- Sony, 10
- Broadcom, 14
- Inside Contactless, 11
- Innovision Research & Technology, 12
- Nokia, 14

IV. LTE Patent Licensing

LTE RAN Products Licensing Power:
Qualcomm v. InterDigital v. Samsung

LTE patent portfolios are researched for US market leader among LTE RAN (Radio Access Network) product (cellular phones, smart phones, PDAs, mobile PCs, base station equipments) manufactures to find out Qualcomm's and InterDigital's licensing power for LTE essential patents. To find the key IPR holders for the LTE patents, a keyword search of the USPTO patent data base has been performed. For completeness, patent data in the lists of patents declared essential to 3GPP LTE appear at the ETSI IPR Online website is also included. Total of 1327 LTE patents, issued and published applications in the US as of December 31, 2010, are analyzed to find essential patent candidates for LTE RAN standards.

3GPP standard specifications for LTE baseband modem are consist of three core parts: OFDM/MIMO Processor (TS36.211), Channel Coder (TS36.212), and Control SW (TS36.213). 3GPP standard specifications for LTE radio protocol SW are consist of four core parts: MAC (TS36.321), RLC (TS36.322), PDCP (TS36.323), and RRC (TS36.331). To evaluate the essentiality of a LTE patent, patent disclosures in claim and detail description for each LTE patent are compared to the final versions of the 3GPP Release 8 technical specifications. Total of 152 patents (15 issued patents and 137 published applications) are identified as the potential candidates for LTE RAN essential patent.

To evaluate the licensing power among LTE IPR shareholders, the identified essential patent candidates are classified by the key technology components for an implementation of the LTE RAN products: OFDM/OFDMA (Frame & Slot Structure, Modulation), SC-FDMA (PUSCH, PUCCH), Channel Estimation (UL RS, DL RS, CQI), Cell Search & Connection (PRACH, DL SS), MIMO (Transmit Diversity, Spatial Multiplexing), Resource Management (Resource Allocation, Scheduling), Coding (Convolution, Turbo), Power Control, HARQ, Random Access, Channel Prioritization, Scheduling (Dynamic, SPS), Protocol Format (PDUs, SDUs), Radio Link Control (ARQ), PDCP Process (SRB, DRB, ROHC), Security (Ciphering, Integrity), System Information, Connection Control, and Mobility (Handover, Inter-RAT, Measurements).

Qualcomm's LTE RAN essential patent portfolio shows the licensing competitiveness over Samsung in cell search & connection, mobility, OFDM/OFDMA, and power control.

InterDigital's LTE RAN essential patent portfolio shows the licensing competitiveness over Samsung in cell search & connection, mobility, security, and power control.

Ref. Figure 7.

Fig. 7 LTE Essential Patents Licensing Power

LTE RAN Competitor Analysis

Legend: Qualcomm, Samsung, InterDigital
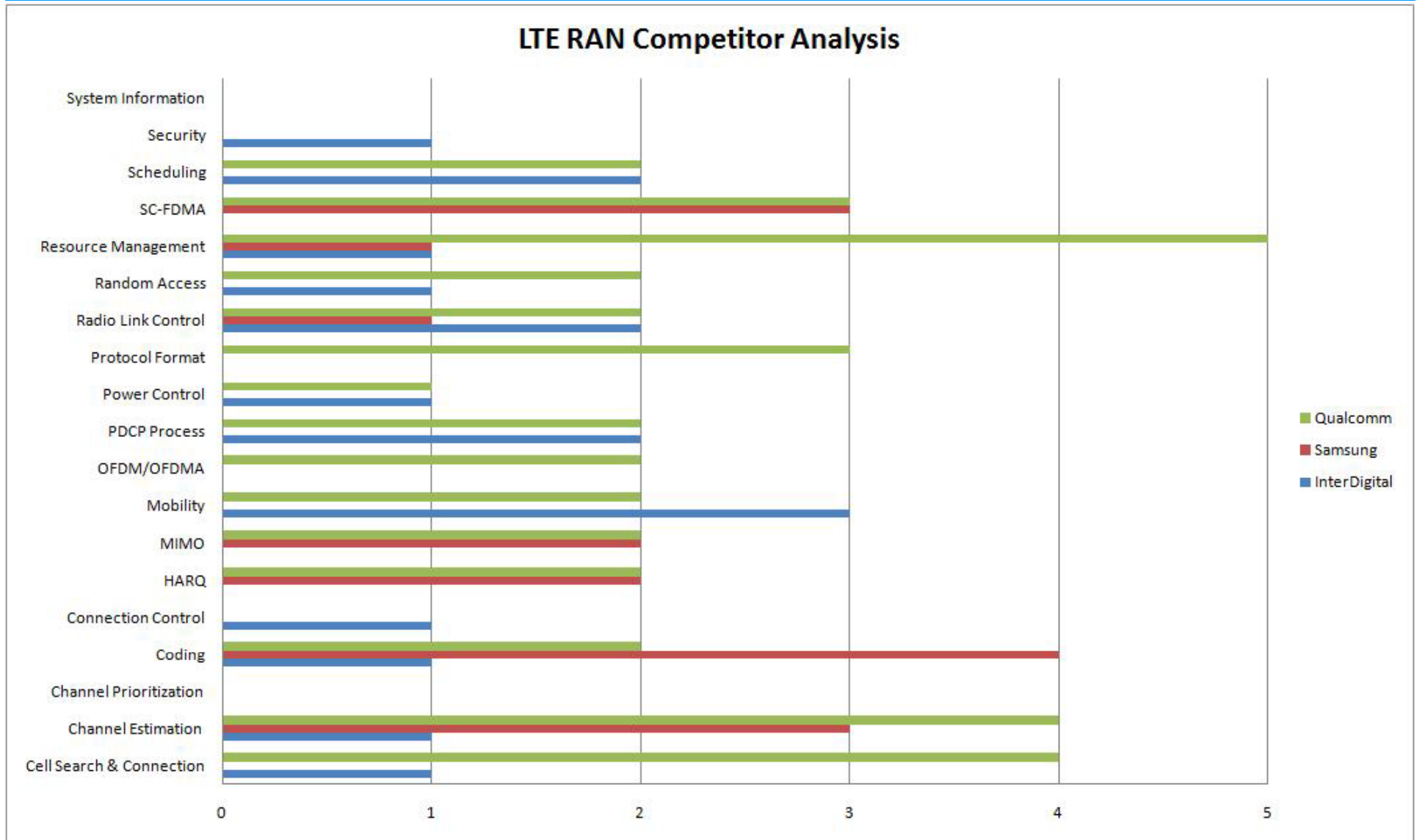
LTE Patent Licensing: Pool v. Bilateral

The LTE IPR shareholders for essential patent candidates are Ericsson, ETRI, Freescale, Huawei, InterDigital, LG, Motorola, NEC, Nokia, Nortel, NSN, Qualcomm, RIM, Samsung, and TI. Among 15 LTE essential patent candidate shareholders, Ericsson, InterDigital, and Qualcomm expressly stated their interest in bilateral licensing for LTE essential patents. The bilateral licensing proponents' IPR share is 38% of the identified potential candidates.

To evaluate the licensing power of the bilateral licensing proponents, the identified essential patent candidates are classified by the key technology components for an implementation of the LTE RAN products.

The bilateral licensing proponents' LTE RAN essential patent portfolio shows the licensing competitiveness over others only in power control. The analysis shows a possibility of forming the LTE patent pool without the bilateral licensing proponents.

Ref. Figure 8.

Fig. 8 LTE Essential Patents Licensing Analysis

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LTE RAN Patent Pool Analysis

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LTE Essential Patent Candidates Data
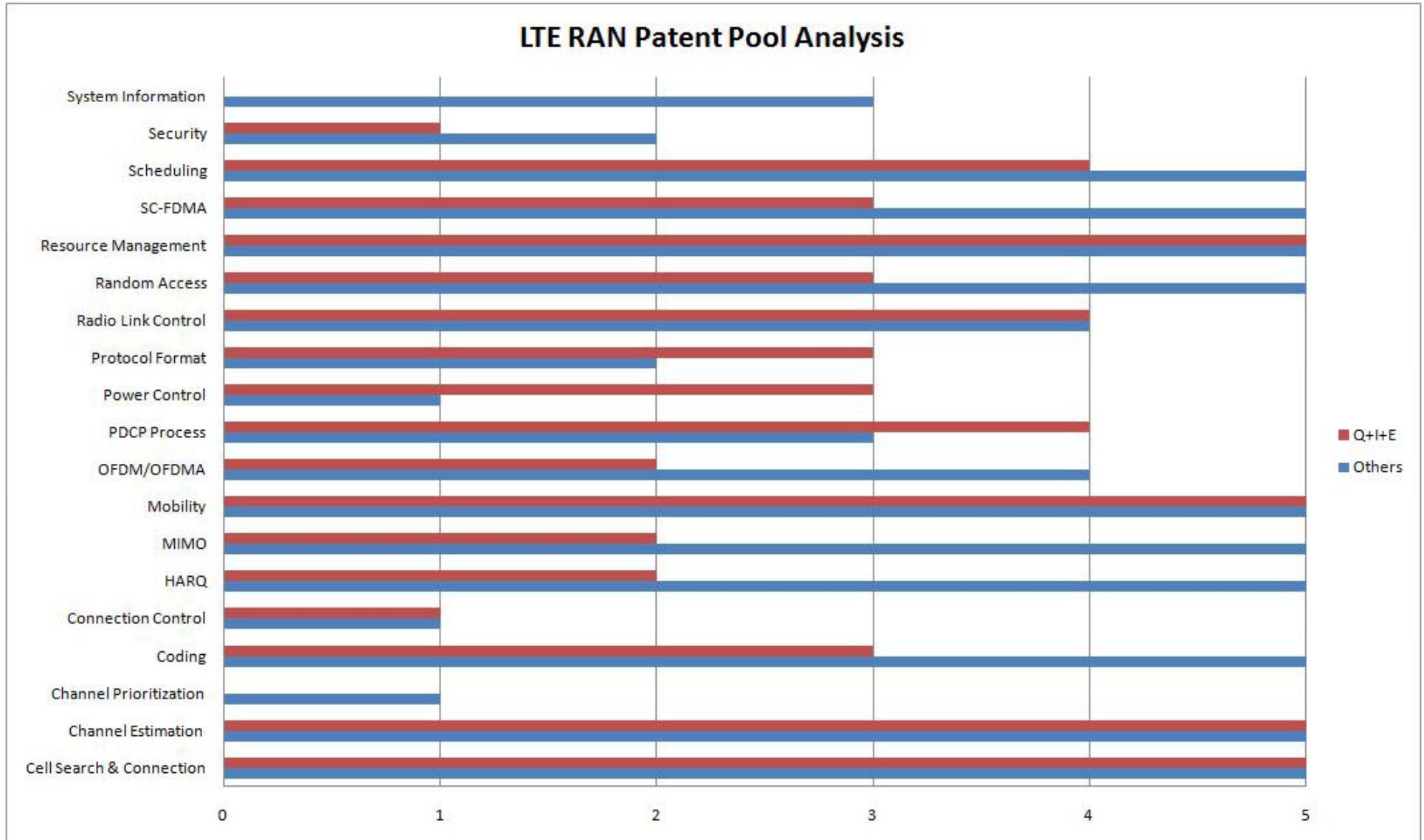
LTE Essential Patent Candidates Data is the TechIPm's product based on LTE patents research for US market leader among LTE UE (cellular phones, smart phones, PDAs, mobile PCs, etc.) and base station (eNB) product manufactures.

To find the key IPR holders for the LTE patents, a keyword search of the USPTO patent data base has been performed. For completeness, patent data in the lists of patents declared essential to 3GPP LTE appear at the ETSI IPR Online website is also included. Total of 1327 LTE patents, issued and published applications in the US as of December 31, 2010, are analyzed to find essential patent candidates for LTE RAN (Radio Access Network) standards. To evaluate the essentiality of a LTE patent, patent disclosures in claim and detail description for each LTE patent are compared to the final versions of the 3GPP Release 8 technical specifications.

LTE Essential Patent Candidates Data -2

LTE Essential Patent Candidates Data provides assignee, patent number, related 3GPP TS36 specifications, and the key technology components for an implementation of the products for total of 152 patents (15 issued patents and 137 published applications) that are identified as the potential candidates for LTE RAN essential patent.

For details about the product, please contact Alex Lee at
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Thank you!

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