MulteFire Release 1.1 Technical Overview White Paper

MULTEFIRE

I. Introduction

MulteFire® is an innovative technology that enables new wireless networks by operating cellular-based technology standalone in unlicensed or shared spectrum. MulteFire 1.0, and its enhancements in 1.1, is an LTE-based technology that operates standalone in unlicensed spectrum, with a roadmap to future solutions based on 5G New Radio (NR). By removing the requirement for licensed spectrum, MulteFire allows anyone to deploy and operate their own private network, targeting areas such as Industrial IoT or enterprises. MulteFire can also be configured as a neutral host network, e.g. for an enterprise or venues, to serve users from multiple operators.

The LTE-based MulteFire Release 1.0 specification was completed in January 2017 by the MulteFire Alliance, which is an open, international organization dedicated to supporting the common interests of its members, developers and users in the application of LTE and next-generation mobile cellular technologies in configurations that use only unlicensed or shared radio spectrum. MulteFire Release 1.0 builds on 3GPP standards and is targeted for operation in the global 5 GHz unlicensed spectrum band but can be used for any band that needs over-the-air contention. It is designed to efficiently coexist with other spectrum users, such as Wi-Fi or Licensed Assisted Access (LAA), using Listen-Before-Talk (LBT).

The Release 1.1 specification, completed in December 2018, brings new optimizations especially for IoT, such as support for NB-IoT and eMTC in unlicensed spectrum; support for new bands such as 1.9 GHz focusing on Japan and lower bands 800/900; and general enhancements to Release 1.0. As Release 1.0 establishes the foundation for the Release 1.1 specification, this paper starts with a brief Release 1.0 overview. Release 1.0 defines an end-to-end architecture design and radio air interface to deliver key performance advantages over alternative solutions in unlicensed spectrum, such as coverage, capacity and mobility.

1. Role of MulteFire 1.0 in Unlicensed Band Technology Evolution

MulteFire 1.0 is tightly aligned with 3GPP standards, and it builds on elements of the 3GPP Release 13 and 3GPP Release 14 specifications for LAA and Enhanced LAA (eLAA), respectively, augmenting standard LTE to operate in global unlicensed spectrum. It implements Listen-Before-Talk (LBT) to efficiently coexist with other spectrum users in the same band, such as Wi-Fi or LAA.

MulteFire 1.0 enables the full range of LTE services including voice, high-speed mobile broadband (data), user mobility and security. It promises LTE-like performance with the simplicity of Wi-Fi-like deployments. As with mobile networks, MulteFire 1.0 enables full mobility as a user walks around a building and enables seamless handover between small cells as required. MulteFire 1.0 will also interwork with external mobile networks to provide service continuity when users leave the area where MulteFire 1.0 service is available.

MulteFire 1.0 can operate anywhere, without costly spectrum or without specialists with expertise in network deployments. It uses many of the sophisticated features designed into LTE to deliver high performance, seamless mobility and resilience, even in highly congested environments. As with Wi-Fi, multiple MulteFire 1.0 networks can co-exist, overlap or be friendly neighbors in the same physical space.

2. Deployment Use Cases for MulteFire

With MulteFire 1.0, private and public vertical venues, IoT verticals, businesses and property owners can create, install and operate their own private or neutral host network in the same way that they do with Wi-Fi. MulteFire 1.0 incorporates high quality LTE services and functionality, supporting voice and data IP services locally, either independently as a private network and/or interworking with existing mobile networks to provide secure, seamless service as a neutral host.

Today, in-building neutral host wireless solutions are common in the context of Wi-Fi and distributed antenna system (DAS) deployments and are occasionally employed in macro-cell environments. However, the neutral host option – a common deployment serving subscribers from multiple operators – has rarely been adopted in the deployment of licensed band small cells. MulteFire 1.0 has the potential to unlock the adoption of small cells and enable neutral host deployments on a much larger scale. Additionally, it could form a useful multi-operator solution for building owners at lower cost than today's DAS by acting as a neutral host or single-operator enterprise solution.

MulteFire 1.0 creates new business opportunities that allow new market verticals to benefit from the LTE technology and ecosystem. These verticals include large enterprises, sports & entertainment, healthcare, identity management, public venues (malls, airports), hospitality, transportation applications, mobile-to-mobile (M2M), IoT, and the public sector (first responders, smart grids, military bases and barracks, universities, hospitals, education authorities). Each of these verticals can create customized applications and Quality of Experience (QoE) for its users.

The following are MulteFire's key performance advantages thanks to the use of LTE technology:

- End-to-end architecture from general design to support for various deployment modes
- Radio air interface, including frame structure and uplink transmission scheme leveraging eLAA robust anchor carrier design, LBT design, key procedures such as random access procedure, mobility, RRM (Radio Resource Management) measurement and paging
- Better radio coverage:
    - Retains LTE's deep coverage characteristics in an unlicensed band
    - Targets control channels to operate at cell-edge SINR of -6 dB
    - Adds a 5-6 dB link budget advantage over carrier-grade Wi-Fi
- Enhanced capacity in denser deployments:
    - Significant gains (~2X) over 802.11ac baseline
    - Leverages LTE link efficiency and MAC
- Seamless mobility:
    - Brings carrier-grade LTE mobility to unlicensed and shared spectrum
    - Backward and forward handover supported (as in 3GPP Rel. 12)

    - Provides seamless and robust mobility between MulteFire 1.0 nodes themselves for all use cases and when moving between MulteFire 1.0 RAN and Macro Network depending on deployment model Network
    - Service continuity to Wide Area Networks (WAN) when moving to/from a neutral host deployment
- Increased robustness:
    - Forward handover enables recovery when radio link failures occur
    - Enhanced radio link failure triggers
    - Leverages LTE mature Self-Organizing Network (SON) techniques

II. MulteFire 1.1 Overview

MulteFire 1.1 represents an evolution of MulteFire 1.0 technology with the aim to further improve its performance and enhance its potential, while maintaining backwards compatibility with MulteFire 1.0. The MulteFire Alliance announced its completion in December 2018. MulteFire 1.1 further expands business opportunities by providing a broader range of services, such as eMTC and NB-IoT in unlicensed spectrum, and access to new spectrum bands. MulteFire 1.1's advantages can be summarized in the following areas:

- Enhancing existing MulteFire 1.0 broadband services in 5 GHz
    - Shorten access time—Grant-less Uplink (GUL)
    - Balance uplink and downlink coverage — Wideband Coverage Enhancements (WCE)
    - More robust mobility—Autonomous UE Mobility (AUM)
    - Self-Organizing Network (SON) features from LTE
- Expanded IoT services with low power wide area support
    - eMTC (1.4 MHz) in unlicensed bands (aka eMTC-U)
    - NB-IoT- (200kHz) in unlicensed bands (aka NB-IoT-U)
    - Expands range of IoT services in addition to broadband in 5Ghz (10/20 MHz carrier bandwidth)
- Added lower spectrum bands focusing on IoT
    - 2.4 GHz unlicensed for eMTC
    - 1.9 GHz targeting sXGP in Japan leveraging existing band 39 devices, aka as DECT spectrum globally
    - Sub-1-GHz in the 800 and 900 range for NB-IoT

1. Enhancements for Existing MulteFire 1.0 Broadband Services in 5 GHz

1a. Grant-less Uplink (GUL)

A scheduling-based system promises better uplink (UL) performance than an asynchronous and autonomous random access system, such as Wi-Fi, when the system has exclusive rights to use the medium. In fact, a MulteFire 1.0 system outperforms a Wi-Fi baseline by providing a better link and less contention through scheduled access. However, the UL performance of MulteFire 1.0 is highly degraded when it is operating with another incumbent technology such as Wi-Fi, which is characterized by a decentralized and asynchronous random access to the radio channel for data transmission, rather than a scheduled access. In this scenario, the UEs in the MulteFire 1.0 system have a disadvantage compared to Wi-Fi technologies in accessing the channel as they need to go through the following contentions:

1. When the UE has data to transmit, the UE must send first a scheduling request (SR) to the serving eNodeB (eNB) to request UL resources. To do so in the MulteFire 1.0 system, the UE has to first perform LBT to acquire the medium, before it can transmit the SR.
2. Once the SR is received, the eNB prepares an UL grant for certain subframe(s) to the UE, and the eNB shall acquire the channel by means of LBT again.
3. After receiving an UL grant, the UE needs to acquire the channel for UL data transmission by means of LBT, unless the switching gap is less than 16us within one MCOT.

In the case that a UE has received an UL grant and LBT is needed but fails the UE loses its opportunity to transmit, and the related frequency/time domain resources for the SR and UL grant transmission are wasted. The UE can perform a transmission for the same data only after the eNB detects that the expected transmission failed, and re-schedules the same data transmission, which leads consequently to increasing overhead and the delay to get data packets transferred over the uplink.

On the other hand, Wi-Fi operates asynchronously and autonomously where the nodes are not restricted by grant assignments for transmissions at specific intervals. This allows a Wi-Fi node more flexibility in contending the channel and acquiring it for transmission access. In fact, Wi-Fi terminals have indeed a natural advantage over MulteFire 1.0 terminals in UL data transmission, since multiple contention operation within one data transmission procedure significantly limits the UL access opportunity for MulteFire 1.0 systems.

To improve the UL performance, a GUL transmission procedure is introduced in MulteFire 1.1. GUL provides an effective way in improving the MulteFire 1.0 UL performance, due to the following advantages:

1. 1. GUL is an evolution of MulteFire 1.0, and it inherits all its benefits, while maintaining backwards compatibility.
2. The UL autonomous transmission does not rely on a SR request. Therefore, if within a predefined set of radio resources, which are configured on a per-cell basis, a UE succeeds LBT, then it can start transmitting immediately as Wi-Fi. Thus, it does not suffer from the multiple contentions imposed on the scheduled UL access.
3. It will naturally coexist well with Wi-Fi as the UE behavior is not different from Wi-Fi stations.

GUL is expected to operate with other incumbent technologies, such as Wi-Fi deployments of 802.11n/ac. It is also expected to operate with 3GPP Further Enhanced Licensed Assisted Access (feLAA) networks, which have introduced autonomous uplink access. The design of this autonomous UL for feLAA has high resemblance with GUL, and the differences between the two features are minimum.

1b. Wide-Coverage Enhancement

Over the past few years, with the advent of low-power processors, low-power sensors, and intelligent wireless networks, there has been an increasing interest in industrial IoT, especially in the enterprise market. A typical industrial IoT scenario includes a maritime port, in which many automated guided vehicles (AGVs) are used to enable faster delivery of goods and products in warehouses and manufacturing units, moving around the whole area while they are controlled and may communicate with each other wirelessly. In this context, a high attenuation of the wireless signals is expected due to unavoidable blocking between AGVs or containers, which might obstruct the safe and correct operation of these devices. To this end, a robust wireless connection is required to support continuous connectivity in this typical scenario. Apart from eliminating the problem related to the robustness of the wireless signal, better coverage can help to substantially reduce the cost for deploying such a network from a customer point of view.

MulteFire 1.0 has enabled an LTE cellular system to operate solely on unlicensed bands, and therefore allows the complete cut of any costs related to the use and management of the licensed spectrum. While the design of MulteFire 1.0 can provide better and more robust links than competing technologies, due to the limitations imposed by the regulatory requirements on the unlicensed bands, this design does not offer the necessary coverage to address deployments as those mentioned above. To overcome this issue, the WCE enhancement is introduced in MulteFire 1.1, with the aim to improve the downlink (DL) link budget for this type of system. According to the maximum coupling loss (MCL) evaluations performed during this work item (WI), WCE allows to improve the DL performance by nearly 8 dB compared to MulteFire 1.0.

1c. Autonomous UE Mobility (AUM)

When operating a network with mobility in the unlicensed bands, there are several potential challenges which arise from the combination of low transmit power, coexistence requirements and device mobility. The low transmit power of all nodes will cause the cell sizes to become relatively small, while device mobility might cause the system to have a short time to handle the entire handover procedure when UEs move towards a cell having better link conditions. On top of this, the

LBT procedure that is required for coexistence may cause a blocking of the transmission from either the eNB or the UE, which results in lost or delayed messages and delayed/outdated measurement reports. Having delays during the handover procedure in such small cells can potentially cause the UE to be out of coverage of its original source cell before it is able to complete the handover towards a target cell.

To address this problem, MulteFire has introduced Autonomous UE Mobility (AUM), which is a new feature to complement the normal eNB controlled handover procedure. When a UE is being configured for AUM mode, it is pre-configured with one or more potential target cells, and upon certain conditions being met, the UE may autonomously contact the target cell without informing the source cell, thereby reducing the vulnerability of the aforementioned mobility challenges. The pre-configuration of the UE for AUM mode may be based on reported measurements or the eNB might configure UEs blindly for AUM operation. In short, a UE can be configured on a per-cell basis by the source cell to autonomously trigger and perform handover, without receiving an explicit handover command or informing the source cell.

1d. Self-Organizing Networks (SON)

SON encompasses solutions to self-configure and self-optimize a network. It was introduced in LTE to facilitate the deployment of a system, and to allow for further performance optimization. The first SON features, i.e. Physical Cell Identity (PCI) allocation and Automatic Neighbor Relation (ANR), were introduced in 3GPP Release 8, while the term "SON" was introduced in 3GPP Release 9. The success of these two features encouraged further study on this topic and led to a Work Item (WI) in 3GPP Release 9 that enabled three more SON features: Mobility Robustness Optimization (MRO), Mobility Load Balancing (MLB) and RACH optimization. Among these new SON features, MRO and MLB turned out to be key enablers for LTE, and they were further enhanced in the following releases to match the increasing complexity of the LTE design. Besides the aforementioned features, other SON related features were discussed and enabled in subsequent 3GPP study items (SIs) and WIs, such as Energy Saving (ES), inter-cell interference coordination (i.e., ICIC), enhanced interference mitigation and traffic adaptation (eIMTA), and coordinated multi-point (CoMP) operation.

Considering the role that SON has played in LTE in helping operators deploy and increase the robustness of the LTE networks, this feature is introduced in MulteFire 1.1. In MulteFire 1.0, two separate network architectures were developed: i) a Public Land Mobile Network (PLMN) Access Mode, and ii) a Neutral Host Network (NHN) Access Mode. While the PLMN access mode uses the legacy LTE network architecture, the NHN Mode is a new self-contained network, which enables access authentication with or without a SIM card to provide services for subscribers from different types of service providers, including traditional mobile network operators as well as non-traditional participating service providers. In MulteFire 1.1, SON features have been introduced focusing on the network self-configuration or the network optimization of stand-alone networks operating in unlicensed spectrum and networks deployed with the NHN architecture.

2. Supporting eMTC in the Global 2.4 GHz Unlicensed Band

The MulteFire 1.1 eMTC solution in unlicensed spectrum (eMTC-U) is aligned as closely as possible with 3GPP for the potential to have a single chip solution for both licensed and unlicensed operation and thereby a further reduction in UE cost. Another benefit is time to market due to the lower development cost and risk.

The Industrial IoT landscape is increasingly global which demands a global solution. The 2.4 GHz band is chosen as it is globally available but subject to regional regulations. eMTC-U uses a single physical layer design which is compliant to both ETSI and FCC regulations. This means simpler UE designs and higher volumes.

The primary use case for eMTC is for an outdoor eNB to reach an eMTC UE which could be located deep within a building. Since eMTC-U uses unlicensed spectrum with reduced max Tx power regulations and mainly will be deployed indoors, the maximum couple loss target will be scaled down accordingly. While eMTC supports coverage extension mode A and mode B per 3GPP standards for deep coverage, only mode A operation is targeted. This means a more modest number of repetitions for channels is required (32 vs 2048). The target maximum coupling loss (MCL) is 135 dB given a 20 dBm output power limitation imposed by regulations.

As the market demand suggests there will be millions if not billions of devices deployed in the near future. The eMTC requirements for device density has several models. The requirement for eMTC-U targets the London dense urban model which is ~13000 devices/sqkm. Considering the propagation loss at 2.4 GHz, 20 dBm maximum output power and indoor usage, typical cell sizes can range from 50 to 250 meters radius. Given the device density requirements a 250-meter cell should support ~2500 devices.

UE cost is related to the UE complexity and the production volumes. The following UE aspects are considered:

- Peak Data Rate is determined by the transport block size. LTE eMTC supports a peak data rate of 1 Mbps and the same target is used for unlicensed eMTC. Since access to the medium can be limited due to interference of other users, the average throughput will be lower than for LTE eMTC.
- Tx Power Reduction to 20 dBm allows more efficient IC packaging and thus reduces cost.
- Single RX Antenna lowers cost in the RF and the baseband. The penalty is reduced coverage and the loss of some advanced transmit modes.
- Bandwidth of 1.4 MHz is the target for the UE. Compared with a 20 MHz LTE UE, reducing the bandwidth to 1.4 MHz results in a cost reduction of up to 39%. Cost saving come from lower requirements for baseband processing and memory, as well as on the RF side with respect to lower requirements on the power amplifier.
- Battery Consumption is related to the supported traffic model. eMTC-U devices are expected to remain dormant in the order of hours and wake up and transmit data on the order of several hundred bytes. The wake-up procedure must be efficient and cell synchronization must be quick. Devices are remote and may be difficult to access. It is expected that the battery life be above 10 years in the field.

3. MulteFire NB-IoT-U: The New Generation LPWA

3a. Motivations to Enable Cellular NB-IoT in Unlicensed Spectrum, and the Relationship with 3GPP NB-IoT

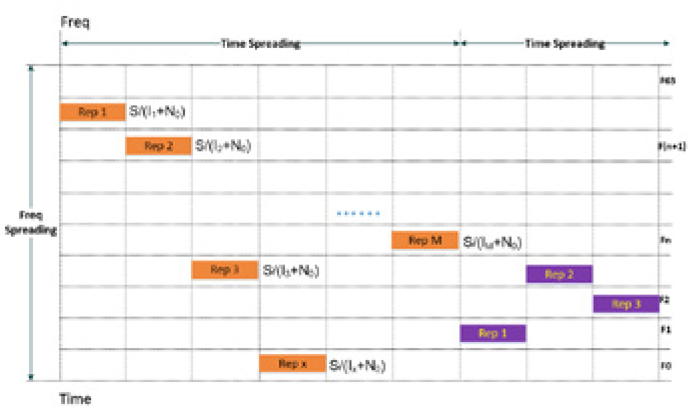
The cellular NB-IoT is an LPWA (Low Power Wide Area) technology, which was originally designed in 3GPP in Release 13 for wireless network operators; it has been continuously enhanced in Releases 14, 15, and 16. It is now evolving as one of the key technologies for 5G next generation wireless system. As of early 2018, there are 46 NB-IoT networks deployed worldwide, and the market adoption is progressing at an accelerated rate.

Enterprise customers in the verticals are expecting an LPWA solution that is suitable for use in the license-exempted spectrum. A solution that shares the cellular IoT ecosystem will satisfy the enterprise customers' requirements for a dedicated IoT network and is also beneficial for the mobile operators' market as expanded chipset volume can help lower the chipset price further. Technically, many of the advanced wireless techniques in cellular systems are proven to offer better performance for IoT connections, which will address the concerns in the market around performance issues of existing LPWA systems. Those cellular techniques include advance Modulation and FEC (Forward Error Correcting Coding), Adaptive Modulation and Coding, as well as Hybrid ARQ, etc. Most of the existing LPWA systems are either fully or partially proprietary, and they are usually much too simplified for cost saving purposes, while the performance is inevitably compromised. MulteFire is in the unique position to enable cellular NB-IoT in the spectrum which can be the new generation LPWA technology long desired by the market.

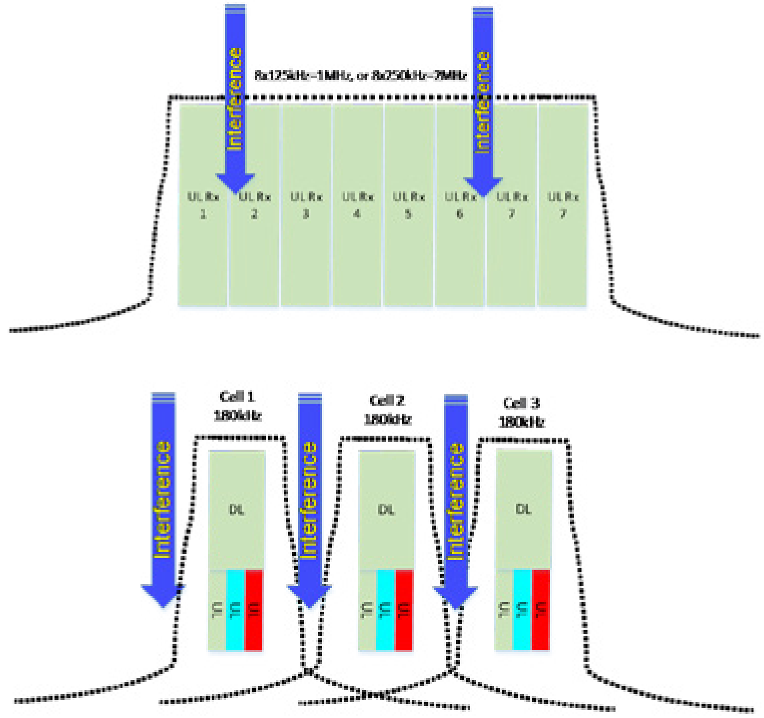
3b. Spectrum and Coexistence with Other Systems

The MulteFire NB-IoT-U is designed for wide area coverage so it's desirable to operate in the low frequency bands below 1 GHz. It is particularly optimized for ISM 902-928MHz governed by FCC regulations, and for 863-870MHz band governed by EU regulations and requirements. Particularly, the MulteFire NB-IoT-U performs frequency hopping for data transmissions for FCC regions, and is duty cycle limited in EU regions. Both mechanisms reduce the possibility to collide with the transmissions from other systems in the shared spectrum used on a best effort basis, without the need of LBT (Listen-before-Talk). LBT is not a preferred technique for low cost IoT systems due to high sensitivity requirements to sense transmissions over a long distance.

The MulteFire NB-IoT-U has very good coexistence properties with other license-exempt systems in the shared spectrum. It is a time-spreading system and the coverage extension is realized by means of repetitions in time domain so that it is inherently robust in license-exempt spectrum as collisions of one or a few repetitions don't ruin the whole transmission. In case of FHSS (Frequency Hopping Spread Spectrum), it is also a frequency-spreading system and the whole transmission is further distributed across a wide bandwidth which improves the communication robustness further.



Both the eNB and UE receiving bandwidth in MulteFire NB-IoT-U is limited within 180kHz. Co-channel interference for wideband systems is reduced as adjacent channel interference which can be further rejected by the selectivity of narrow band receiver.



The key features of MulteFire NB-IoT-U include:

- Extended coverage: depending on the allowed transmission power, the coverage can be as large as 161dBc (for power allowed by FCC) and 154dBc (for power allowed by EU).
- Low power consumption system for battery operated IoT communication: the system is optimized for battery operated IoT communications. For nominal infrequent IoT traffic (such hundreds of bytes per two hours), three AAA batteries could operate for multiple years of communication life.
- Low cost device: the system is optimized to support terminal chipset with very low complexity resulting very low device cost.
- Massive connectivity: Each base station is capable to support more than 50,000 terminals following the typical traffic pattern specified in 3GPP TR45.820.

3c. Sharing the Eco-System with Cellular NB-IoT by Sharing the Common Design

The major changes of MulteFire NB-IoT over cellular NB-IoT is on the lower physical layer in which a common design for NPSS/NSSS/NPBCH transmission is re-organized for better performance and for the convenience of regulation compliance.

Other physical channels and physical procedures of NB-IoT as well as the high layer protocols are the same as 3GPP NB-IoT.

4. MulteFire in 1.9 GHz

4a. Existing Technologies in 1.9 GHZ Spectrum

In 1.9 GHz spectrum, DECT (Digital Enhanced Cordless Telecommunication) systems have been widely deployed in more than 100 countries. PHS (Personal Handy-phone System) can also be deployed in Japan, Korea, Australia and other Asia-Pacific countries where regulations are permitted. The 3rd Generation Partnership Project (3GPP) Time Division Long Term Evolution (TD-LTE) Band 39 system has only one network deployed in China by China Mobile, but more than 1400 types of LTE terminals all over the world support Band 39.

4b. Design Targets and Requirements of MulteFire in 1.9 GHz

MulteFire is a new, innovative technology designed to create new wireless networks by operating LTE technology standalone in unlicensed or shared spectrum. The MulteFire Release 1.0 specification was completed in January 2017 by the MulteFire Alliance. The MulteFire Alliance is an open, international organization dedicated to support the common interests of its members, developers and users in the application of LTE and next generation mobile cellular technologies in configurations that use only unlicensed radio spectrum.

To fully utilize the legacy LTE eco-system, which can largely reduce the system cost and achieve quick time-to-market, the key target of MulteFire in 1.9 GHz is to reuse the existing Band 39 terminals. Furthermore, minor modification at eNB side is needed to obtain co-existence with DECT and PHS systems. MulteFire in 1.9 GHz can operate anywhere with no need of extra costly spectrum or specialists in network deployments. To deliver high performance, seamless mobility and resilience network, many legacy sophisticated LTE features are reused in 1.9 GHz MulteFire systems.

4c. Deployment Use Cases for MulteFire in 1.9 GHz

Same as PHS and DECT systems, one of the targeted deployment scenarios for MulteFire in 1.9 GHz is to provide enhanced cordless phone services within enterprise, private and public venues. Voice services within enterprises can be operated within MulteFire networks. MulteFire networks can also be used as RANs to provide connectivity to PSTN (Public Switched Telephone Network) via PBX (Private Branch eXchange) and provide dial in and dial out phone calls outside enterprises in the same ways as LTE RANs.

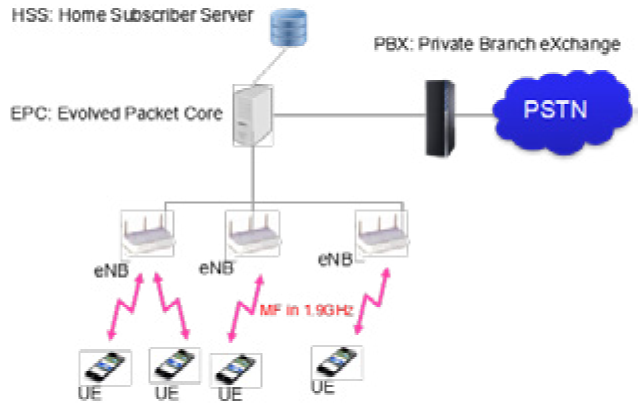


Figure 1. Enhanced Office Cordless Telephone System

Besides voice and data services, various IoT and M2M services can also be supported by MulteFire in 1.9 GHz. Band 39 LTE terminals can also be used for IoT services which have high data rate requirements (e.g. more than 5Mbps). The Band 39 Cat. 0 and eMTC terminals can support IoT services with medium data rate requirement (e.g. less than 1Mbps). In the near future, Band 39 NB-IoT terminals can also be utilized to extend IoT services with low data rate requirement (e.g. less than 100Kbps) and further reducing the UE power consumption.

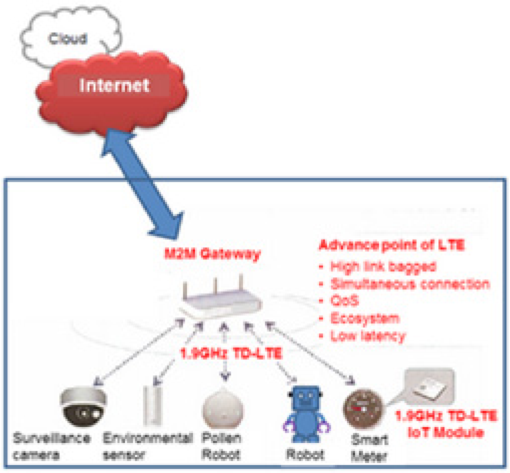


Figure 2. Evolution of M2M & IoT Solutions

4d. Sharing the Existing Cellular Eco-System by Reusing the Existing Terminals

MulteFire in 1.9 GHz expands the MulteFire technologies to 1.9 GHz spectrum, which can reuse the existing TD-LTE device eco-system and shorten the time-to-market. At the network side, LBT functions are added on top of TD-LTE system and can achieve co-existence with incumbent systems. Moreover, MulteFire in 1.9 GHz system achieve higher peak data rate by higher modulation order and wider bandwidth compared to legacy systems. Finally, 3GPP IoT use cases can also be supported by MulteFire in 1.9 GHz which enlarges the potential market size. Today, commercial products of MulteFire in 1.9 GHz in Japan are now available and have passed the TELEC certification. Many trials and demonstrations are organized by potential big customers, e.g. enterprises and universities

4e. Future Work

The MulteFire Alliance is now drafting interoperability test specifications to ensure the system performance and the formal test program will be finalized and published by Q2 of 2019. Besides the Japanese market, the MulteFire Alliance is also driving to bring the MulteFire 1.9 GHz technology to other regions which have similar regulations to Japan.

III. Conclusion

MulteFire 1.0 technology was designed to create new wireless networks by operating LTE-based technology standalone in unlicensed or shared spectrum bands. MulteFire 1.1 takes the potential of this technology even further. Its key features include Enhanced MulteFire 1.0 broadband services in the global 5 GHz unlicensed band; Added additional spectrum bands focusing on IoT; and Expanded IoT services with low power wide area support.

Optimized for IoT, the MulteFire Release 1.1 specification delivers the robust wireless network capabilities required by Industrial IoT and Enterprises to meet their specific requirements for performance, latency, security and mobility.

MulteFire is a new way to wireless.

References

[1] DECT Forum
[2] GSMA Report
[3] ARIB Specification
[4] Technical requirement for improvement of digital cordless phone radio station

Glossary of Terms

3GPP – Third Generation Partnership Project
AGV – Automated Guided Vehicle
ANR – Automatic Neighbor Relation
AUM – Autonomous UE Mobility
B-IFDMA – Block Interleaved FDMA
BLER – Block Error Rate
CBRS- Citizens Broadband Radio Service
CoMP – Coordinated Multi-Point
CP – Cyclic Prefix
CQI - Channel Quality Indicator
C-RNTI – Common Radio Network Temporary Identifier
DAS - Distributed Antenna System
DL – Downlink
DCI – Downlink Control Information
DMRS – Demodulation Reference Signal
DMTC - DRS Measurement Time Configuration
DRS – Discovery Reference Signal
GUL – Grantless Uplink
GUL DCI – Grantless uplink Downlink Control Information
GUL UCI – Grantless Uplink Uplink Control Information
eIMTA - Enhanced Interference Mitigation & Traffic Adaptation
eNB – eNodeB
eLAA - Enhanced Licensed Assisted Access
ePDCCH – Enhanced Physical Downlink Control Channel
ES – Energy Saving
feLAA - Further Enhanced Licensed Assisted Access
HARQ – Hybrid Automatic Repeat Request
HO - Handover
ICIC - Inter-Cell Interference Coordination
ID - Identifier
IoT – Internet of Things
MCS – Modulation and Coding Scheme
PUCCH – Physical Uplink Control Channel
PUSCH – Physical Uplink Shared Channel
LAA – Licensed Assisted Access
LBT – Listen-Before-Talk
LTE – Long Term Evolution
M2M – Mobile-to-Mobile
MCL – Maximum Coupling Loss
MCOT – Maximum Channel Occupancy Time
MF - MulteFire
MIB – Master Information Block
MLB - Mobility Load Balancing
MNO – Mobile Network Operator
MRO - Mobility Robustness Optimization
NHN – Neutral Host Network
NW – Radio Network
OFDM – Orthogonal Frequency Division Multiplexing
PBCH – Physical Broadcasting Channel
PCI – Physical Cell Identity
PLMN – Public Land Mobile Network
PMI – Precoding Matrix Indicator
PRACH – Physical Random Access Channel
PSS/SSS – Primary and secondary Synchronization Signal
QoE – Quality of Experience
RACH - Random-Access Channel
RLF – Radio Link Failure
RNTI – Common Radio Network Temporary Identifier
RRC – Radio Resource Control
RSRP - Reference Signal Received Power
SI – Study Item
SIB – System Information Block
SIM – Subscriber Identity Module
SINR – Signal-to-Interference and Noise Ratio
SON – Self-Organizing Network
SPS - Semi-Persistent Scheduling
SR - Scheduling Request
TxOP – Transmission Opportunity
UCI – Uplink Control Information
UE – User Equipment
UL – Uplink
UPT – User Perceived Throughput
VoLTE - Voice over LTE
WCE – Wide-Coverage Enhancement
WI – Work Item

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