Interoperability of pans, lans and wans

Sociology, Communication

Abstract

With the explosive growth of mobile wirelesscommunicationtechnologies, network integration is vital for next generation wireless networks as the different technologies available have been optimized for diverse usage models. This paper addresses the interoperability of Bluetooth, WLAN and WiMax focusing mainly on interference and handover management. Firstly the coexistence issue of Bluetooth, WLAN and WiMax is addressed as they operate in the adjacent (almost overlapping) bands. Secondly a new standard aimed at providing a framework for media independent handover (MIH) among diverse networks is presented. Finally using a usage scenario, it is further shown how the MIH framework helps in the handover management taking into consideration user preference and available resources in the above named networks.

Keywords: MIH; interoperability; coexistence;

Introduction

Wireless communication growth has been on the increase in the past years, thanks to the advantages they offer which include deployment flexibility, compatibility and user mobility during communications. Emerged technologies have been designed independently to deal with specific service types, usability domains and user categories..

The need to optimize performance led to the integration of radio access technologies to extend service availability as users expect to be globally reachable everywhere and at all times to the best network possible. For this

to be feasible, access networks have to work together to enable users take full advantage of the available options (Piris et al 2009).

The IEEE 802. 21 standard which provides a framework for Media-Independent Handover (MIH) in diverse networks is discussed in this paper. This standard defines three types of MIH services (event, command, and information) that facilitate the mobility management and handover decision making (lim et al 2009). The interoperability of Bluetooth, WLAN and WiMax is addressed from the interference and handover perspective. The problem of mutual interference between Bluetooth, WLAN and WiMax is analyzed using time multiplexing enabling their coexistence and to further aid their interoperability, the IEEE 802. 21 standard which seamlessly enables handover (which occurs frequently due to user preference or allocated resources) among diverse networks is discussed.

This paper is organized as follows: Section 2 starts with a background which provides an overview of the wireless technologies considered above. In Section 3, using a collaborative technique, the coexistence problem of Bluetooth, WLAN and WiMax is addressed, the section goes further on to analyze how the IEEE 802. 21 standard makes possible the interoperability of the three technologies. Section 4 provides an illustrative use case that highlight the usage of the Media-Independent Handover Services standard in an integrated wirelessenvironmentand some issues associated with their interoperability is discussed. Finally, the paper ends with conclusion and future directions.

2. 0Background

2. 1. Bluetooth (PAN)

As stated by Bhagwat (2001), Bluetooth 1. 1 is a short range wireless linktechnologyintended for cable replacement. Bluetooth operates in the 2. 4 GHz ISM frequency band. As seen in Golmie (2001), Bluetooth’s air interface is based on an antenna power of 1mW and uses Gaussian frequency shift keying (GFSK) as its modulation scheme. Time Division Multiplexing (TDM) divides the channel in 625μs slot and support a data rate of 700kbps to 3Mbps. Bluetooth uses frequency hopping spread spectrum (FHSS) Song et al (2007).

Bluetooth uses authorization and authentication to verify users and their right to connect with each other. As indicated by Johansson et al (1999), Authentication in Bluetooth uses the challenge–response strategy and connection may require a one way, two-way or no authentication which is achieved based on the stored link key or by pairing. Traskback (2000) adds that there are three different security modes present in Bluetooth, Mode 1, 2 and 3.

2. 2. WLAN(LAN)

802. 11 is a collection of standards for implementing WLAN communication in the designated frequency bands. Currently there are about twenty two(22) amendments(Labiod et al 2007)which all adopt the media access technique called Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA). This work is focused on the 802. 11g specification. Song et al (2007) indicates that 802. 11g has a coverage of about 75 feets, supports the Direct squence

spread spectrum and Orthogonal Frequency Division Multiplexing signalling method to attain a maximum data rate of 54Mbps. 802. 11g operates in the 2. 4GHz band.

Security in WLAN can be achieved by deploying an authenication mechanism as a means to WLAN access contol and providing confidentiality for wireless data by establishing encrption. The EAP-TLS which provides certificate-based authentication for WLANs, a replaced WEP as it satisfied all the required properties of authentication protocols (Tavallaee, 2007).

2. 3. WIMAX(WAN)

Wimax operates on FCC licensed frequency range of 10 to 66GHz and unlincensed frequencies of 2 to 11GHz and has a theoritical bandwidth and range of 75Mbps and 50Km respectively. IEEE 802. 16e, the mobile version of Wimax will be considered in this paper, 802. 16e works in the 2. 3GHz and 2. 5GHz frequency bands and uses OFDM (Zhang & Chen, 2008)., the WiMAX MAC is centralized and connection-oriented unlike WLAN MAC that is distributed and connectionless (DeBeasi, 2008). Security in WiMax is based on authentication, encryption and authorization.

3. 0 Bluetooth, WLAN and WiMax Interoperability

This section analyzes a solution from the MAC layer to handle the coexistence issue between WiMax , WLAN and Bluetooth and to further aid interoperability, discusses the implementation of the IEEE 802. 21 standard which enables seamless handover among diverse networks.

3. 1Solution to the coexistence problem of WiMax, Bluetooth and WLAN

The idea is to synchronize the different protocols to ensure that their bandwidth over a shared spectrum is allocated in a time multiplexed, non-concurrent but fair way. By this, interference can be eliminated when these technologies operate in an integrated environment. Considering a usage scenario where a Mobile node(MN) uses a Bluetooth enabled wireless headset to conduct a cellular conversation, while simultaneously downloading email or browsing the Internet through the phone's WiMax and WLAN air link interchangeably, Time division multiplexing is uses to mitigate interference as Bluetooth, WLAN and WiMax(band class 2 and 3) operate at adjacent frequencies bands (almost overlapping) thus causing conflict and severe performance degradation(Bitran & Eshed, 2007)

Firstly, the protocols are synchronized in time. A lowest common denominator is found between the different clock systems and are coordinated accordingly. WiMax time base is based on 5ms frame and Bluetooth is based on 625µs per slot. 15ms is considered a common factor between the two system clocks during which 3 WiMax frames and 24 Bluetooth slots will be processed(Bitran & Eshed, 2007).

The addition of the WLAN in the coexistence scheme involves CSMA/CD which is not based on time allocations but on collision detection and the use of random back offs, ibid., p2. To minimize power consumption and to avoid interference, the WLAN interface is set to sleep mode when it is not transmitting and have the access point buffer all its transmissions – up to a predefined buffer size. When the channel is free and it exits the sleep mode, it sends a trigger frame to the access point, who sends all its buffered data.

The figure below is a solution showing how the technologies would operate in the 15ms time interval. Having synchronized the links and identified the fundamental, repetitive pattern, it is essential to ensure that they remain synchronized throughout the concurrent operation of the links.

Figure 1 illustrating time multiplexing of Bluetooth, WLAN and WiMax (Bitran & Eshed, 2007)

The Bluetooth SCO/HV3 profile defines a repetitive six slot period during which two consecutive slots are used for transmission. Because the Bluetooth interface is used in this scenario for transfer of voice, it is given preference. To avoid interruptions, the WiMax base station refrains from allocating transmission opportunities to the slots used by the Bluetooth.

3. 2Seamless Handover

Based on user preference and available resources , the ability to switch (Seamless Handover) between the different technologies has been made possible by the IEEE 802. 21 standard which provides a framework for Media-Independent Handover (MIH) in diverse networks. This is discussed below.

The IEEE 802. 21 standard (media independent handover) was proposed to facilitate interoperability between IEEE 802 and non IEEE 802 technologies (Pontes et al, 2008). The 802. 21 framework is called the media independent handover (MIH). MIH provides link layer intelligence and other related network information to upper layers to optimize handovers (Ying et al, 2008).

It is assumed that mobile Node has interfaces that supports all three technologies. To sustain uninterrupted user connections during handover

across different networks, the handover-enabling functions (MIHF) defined by the IEEE 802. 21 is logically introduced between Layer 2 and Layer 3 of the OSI network stack. The MIHF provides available information from lower layers (MAC and PHY) to the higher layers of the protocol stack which are used to make handover and link-selection decisions.

Figure 2 MIH framework/architecture (Gupta et al, 2006).

As seen in figure 2, The main component of the IEEE 802. 21 framework is the MIHF. It provides a consolidated interface to the upper layers independent of the primary access technologies. This is made possible by three services: The Media-independent event service (MIES), the Media-independent information service (MIIS) and the Media independent command service (MICS)

The MIES provides services to the upper layers by reporting both local and remote events such as changes in link conditions, link status, and link quality.

The MICS enables upper layer manage and control the parameters related to link behavior and handovers. The MICS offer commands to the upper layer, with this commands able to manage and send actions to the lower layers.

The MIIS facilitates handovers by providing a mechanism for the MIHF to discover available neighboring network information within its vicinity. Hence, MIIS allows mobile nodes to check for available networks in range while using their currently active access network.

4. 0 Usage Scenario

Considering the same scenario cited above. FMIPv6 signaling is explicitly included as the Layer 3 mobility management protocol The MN request MIIS information and constantly listens to its interfaces. Upon receiving a signal from a WLAN AP accompanied by a 802. 11 link detected event from the MAC layer sent to the MIHF, the MN becomes aware of a new connectivity opportunity. The event 802. 11 link is sent to the upper layer, particularly sent to FMIPv6 the management protocol which in turn contacts the handover policy engine which pre-verifies the new connection. Depending on the implemented handover policy, the MN searches for information about the new network at the MIIS (such as security, required bandwidth security etc.) Figure 3 shows the operation in detail.

The upper layer executes the handover decision taking into account the user’s preference and the resources available at the new network. After the decision has been made, the FMIPv6 signaling begins as illustrated in the figure above. The MN still stays connected to the previous point of attachment to provide a make-before-break approach enabling seamless hand over. When the FMIPv6’s FNA message is received, it indicates that handover has been completed (Pontes et al, 2008). The MN handover complete message releases the resources allocated by WiMax and deactivates the interface.

Figure 3 WiMax/WLAN handover using the MIH framework with Bluetooth coexistence (PONTES et al 2008)

4. 1. Interoperability Issues.

Inability to control soft handovers: In the absence of an explicit support at the upper layer, an application is unable to benefit from soft handover capabilities when moving across different networks even if soft handovers are possible at the data link layer. The migrated connection are therefore open to packet loss and performance degradation. (Hsien et al, 2004).

Infrastructure Support: Current approaches proposed that Mobile IP (MIP) can handle network layer mobility is only possible if the network provider provides for a home agent. Also the effectiveness of the approaches to achieve host mobility without incurring overhead in different networks, again is limited to the specificity of the networks they are assigned for. (Ibid).

Power and Interference Management: Power management becomes a challenge when diverse access networks are integrated in same device. Bluetooth, WLAN and WiMax(band class 2 and 3) operate at adjacent frequencies bands(almost overlapping) thus causing conflict

End to end security: Ensuring a trusted, efficient and usage-model appropriate means of authenticating users is a key issues in cross-network connectivity. (Hurwitz & Bryan, 2003) as the different network devices have different security settings.

5. 0Conclusion

The emergence of heterogeneous wireless access technologies and their interoperability has been a major concern for future wireless systems. In this paper, the interoperability of WiMax, Bluetooth and WLAN have been discussed. Because no technology is good or generic enough to replace all

others thus combined usage is a good approach to offer the always best connection. The coexistence of Bluetooth, WLAN and WiMax was analyzed first, taking into consideration the fact that the operate in adjacent (almost overlapping) frequency bands, so are subject to interference. Secondly with the use of the MIH framework, the interoperability of Bluetooth, WLAN and WiMax was illustrated through a common scenario. Some issues associated with their interoperability were also mentioned.

For the future, active research should be performed in this area to completely eliminate these interoperability issues to enable users seamlessly utilize services irrespective of the network concerned for better coverage even at a low cost.

Bibliography

Bhagwat, P. (2001). IEEE Internet Computing. Bluetooth technology for Short-Range wireless Apps. , 5 (3), 96-103.

Bitran, Y., & Eshed, E. (2007, June 18). Solving the coexistence of WiMAX, Bluetooth and WiFi in converged handsets. EE Times Design .

DeBeasi, P. (2008, March 24). WiMAX INTRODUCTION. Retrieved from http://www. mobileparadigm. com/my articles/200803. WiMAXPart1. pdf

Golmie, N. (2001). Interference in the 2. 4 GHz ISM band: Challenges and solutions.(online). Retrieved from http://www. antd. nist. gov/pubs/golmie. pdf.

Golmie, N. (2009). Seamless Mobility: Are we there yetIEEE Wireless Communications – National Institute of standards and Technology

Gupta, V., Williams, M. G., Johnston, D., McCann, S., Barber, P., & Ohba, Y. (2006, July 18). IEEE 802. 21 Overview of Standard for Media Independent Handover Services. IEEE 802 Plenary . San Diego.

Han, T., Zhang, N., Liu, K., Tang, B., & Liu, Y. (2008). Analysis of Mobile WiMAX Security: Vulnerabilities and Solutions. IEEE International Conference , 828.

Hsien, H.-Y., Kim, K.-H., & Sivakumar, R. (2004). An End-to-End approach for transparent mobility accross heterogeneous wireless networks. Mobile networks and applications , 364.

Hurwitz, R., & Bryan, P. (2003, November 1). The Future of wireless handsets. Retrieved 2011, from Deviceforge. com: http://www. deviceforge. com/articles/AT7085477626. html

Jahansson, P., Jahansson, N., Korner, U., Jahannes, E., & Svennaqs, G. (1999). 1999 IEEE International Conference Communications, 1999. ICC ’99. Short range radio based ad-hoc networking: performance and properties , 3, 1414.

Jokela, J., Simpson, F., Zaks, A., & Zhu, J. (2007). WPAN/WLAN/WWAN Multi-Radio Coexistence. IEE 802 Plenary. Atlanta.

Labiod, H., Afifi, H., & Santis, C. D. (2007). WI-FI T M , BLUETOOTH T M , ZIGBEE T M A ND WIMAX TM. The Netherlands: The Springer, P. O. Box 17, 3300 AA Dordrecht.

Lansford, J., Nevo, R., & Zehav, E. (2000, Nov 7). IEEE P802. 15 Working Group for Wireless Personal Area Networks (WPANs). MEHTA: A method for coexistence between co-located 802. 11b and Bluetooth systems . Hillsboro.

Lim, W.-S., Kim, D.-W., Suh, Y.-j., & Won, J.-J. (2009). mplementation and performance study of IEEE 802. 21 in integrated IEEE 802. 11/802. 16e networks. Computer communication , 32 (1), 134-143.

PONTES, A. B., SILVA, D. D., JOSE JAILTON, J., & O. R. (2008, October 2008). HANDOVER MANAGEMENT IN INTEGRATED WLAN AND MOBILE WIMAX NETWORKS. IEEE Wireless Communications .

Prince, J. (2006, November 12). Ensuring WLAN, Bluetooth Coexistence. Retrieved March 2011, from http://techon. nikkeibp. co. jp/article/HONSHI/20061121/124164/

Piris, E., & Pentikousi, K. (2009). IEEE 802. 21: Media-Independent Handover Services. Th e I n t e r n e t P ro to c o l Jo u r n a l , 12 (2), 7-27.

Song, M., Shetty, S., & Gopalpet, D. (2007). Mobile Networks and Applications. Coexistence of IEEE 802. 11b and bluetooth: An Integrated Performance Analysis , 12 (5), 450-459.

Tavallaee, M. (2007). “ An Overview of WLAN Authentication Protocols”. Technical report, Univeristy of New Brunswick.

Traskback, M. (2000). Security of Bluetooth. An overview of Bluetooth Security, Department of Electrical and Communications Engineering Helsinki University of .

Vainio, J. (2000). “ Bluetooth security”. Proceedings of Helsinki University of Technology, Telecommunications Software and Multimedia Laboratory, Seminar on Internetworking: Ad Hoc Networking .

Ying, W., Yun, Z., Jun, Y., & Ping, Z. (2008, May 20). An Enhanced Media Independent Handover Framework for Heterogeneous Networks. IEEE Vehicular Technology Conference, 2008. VTC Spring 2008. . , 2306.

Zhang, Y., & Chen, H.-H. (2008). Mobile Wimax : Towards Broadband Wireless Metropolitian Area Networks. NW: Taylor and Francis group, LLC.