Standards Group: R7.5 WG11- Wireless Activity Report
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1 Executive Summary

This report is being provided to the FCC Technological Advisory Committee by the Consumer Electronic Association's Wireless Working Group, R7.5 Work Group 11. It is being provided for informational purposes to identify consumer networking applications and the requirements those applications place on wireless in-home networks with specific emphasis on entertainment applications. The information contained herein, although incomplete, represents the consensus of the working group members, many of whom are leading consumer electronics manufacturers. It is anticipated the work will be completed by the Fall of 2003. CEA and the R7.5 WG11 members welcome questions and comments from the FCC Technical Advisory Committee on this report and on any matters related to wireless in-home networks, and unlicensed spectrum that is or may become available for use by in-home wireless networks.

The CEA R7.5 Work Group 11 addresses subject matter relating to wireless devices and wireless networks for inclusion into consumer home networks. Currently the group is tasked with identifying uses of wireless technologies in AV networks and assessing their associated performance requirements. The group is also producing a survey of wireless technologies options and reporting them to R7.5 subcommittee.

The R7.5 subcommittee develops and maintains standards for interoperability between digital audio-video (AV) entertainment applications of consumer electronics. These standards address interconnection of AV devices and clusters to in-home distribution networks. R7.5 standards span various networking technologies and utilize frameworks that are independent of specific operating systems.

2 Introduction

The work presented in this document is work in progress. The wireless working group has identified common AV and IT applications typically found on wired networks that could also use wireless networks. It is the CEA's view that moving these applications onto a wireless network will provide an "ease of use" benefit to the consumer. However, the applications are typically designed assuming a reliable transport, i.e. continuous connectivity, negligible bit error rate, constant transmission rate, etc. Wireless networks, especially those in unlicensed bands, do not provide the same reliability or bandwidth as wired networks.

This document contains two tables. Table 1 lists applications and application requirements for transport on a network. The intent of this table is to inform network architects and developers of the constraints that a given application requires of a network to work reliably. Table 2 is a survey of wireless technologies and their specifications. Work is still ongoing on this table. Since the contents of Table 2 are still under discussion, the table has been intentionally left empty in this report. However, the row headings have been carefully identified and the working group has reached consensus that these attributes represent those that are important to characterize the capabilities of wireless network technologies for use in a wireless in-home network. Careful consideration is also being given to the specification entries of table 2. The goal of table 2 is to provide meaningful specifications to help a product developer choose the correct wireless technology for a given application, how the application may need to be modified for transport on a given wireless technology, and what level of performance can be expected from a given wireless technology when used for a specific application. Table 2

includes technologies based on open standards as well as proprietary technologies. The next two sections provide more details on each of the tables.

3 Home Networking Applications

Home Networking applications can be roughly characterized in terms of several requirements or combinations of requirements:

- Bandwidth Requirements
- Sensitivity to Delays and / or Jitter
- Sensitivity to Errors
- Security Requirements

For example, Telephony such as Voice-Over-IP has low throughput requirements but high sensitivity to delays and errors and must be secure although there is no requirement for content copy protection. The requirements for video vary based on whether it is streaming to a display or being stored for future viewing, the type and level of security required, the resolution of the content and other factors. Delay may be important if, for example, the application might call for frequent channel changing or if the display device cannot buffer the data but Delay may be unimportant if the data is being stored or buffered. All video is sensitive to errors.

As can be seen from these examples and from Table 1, to understand the requirements for a given application, it is very important to define the application well. No simple table is capable of detailing every possible usage model. Thus Table 1 provides a qualitative indication of the requirements with a range of requirements. It is left to the developer to make the necessary tradeoffs. Some conclusions however can be made based on our findings.

First, wireless networks have inherent limitations as compared to wired networks such as the available throughput and bit error rates. Therefore product developers will be forced to make tradeoffs based on the applications being addressed and the technology they select for their wireless network. Tables 1 and 2 below are being developed to be used in combination to help simplify the process of matching applications to wireless solutions. For example, if a solution is to be used as a general-purpose wireless entertainment network for multiple applications that include watching HDTV, listening to home theater audio, and telephony, it must meet very stringent requirements in most of the categories in Table 1. For a wireless solution to meet these requirements, some tradeoffs may be necessary. The tradeoffs will depend on the wireless solution selected by the developer. To help the developer make such decisions, we have created Table 2, which delves into the capabilities of the better known wireless solutions.

Second, the product developer must have an in-depth understanding of the target application and its intended customers' expectations. This can be seen in the wide range of requirements given for many applications, which in turn will affect the quality and reliability the product developer is targeting. For example, the Typical Payload Bit Rate per Stream for watching broadcast TV is 3-20 Mbps. The range takes into account different video resolutions ranging from standard to high definition as well as different compression levels. As well, while buffering can offset variations in delay and jitter, and help to minimize the effects of bit errors by allowing a technology without forward error correction to retransmit packets. However, it is a tradeoff against delays a user would encounter, for example, when changing channels. The buffer may take some seconds to fill each time the channel is changed resulting in a delay before the user sees the next channel. Using the example of Watching Broadcast TV again, security may not be required if the content does not require copy protection. However, much content is, or will be, protected which will increase the need for security mechanisms. For a product targeting the distribution between rooms of copy-protected HDTV video (20 Mbps), streamed live from a set-top-box along with high quality audio (additive throughput), in a target market that expects the ability to channel surf between HDTV channels (low PER/PLR, low 1-way and round trip delay), the technology must support the higher end of the requirements. If that product must also support additional streams or data, the requirements become even more stringent.

Third, the developer must have an in-depth knowledge of the selected wireless technology. This is necessary to understand its capabilities, and the tradeoffs those capabilities will impose on the end product and ultimately its ability to meet the expectations of the consumer. Table 2 will allow the product developer to narrow the potential solutions but it cannot provide the detail necessary to fully understand the tradeoffs that a technology may impose on a specific product implementation.

Each of the applications detailed in Table 1 have been discussed in detail by the committee members and each places a range of requirements on the technology used.

3.1 Explanation of Requirements:

3.1.1 Typical Payload Bit Rate per Stream

This column indicates the actual throughput in million bits per second required by the application not including messaging overhead, retransmission due to bit errors or lost packets, forward error correction overhead, etc.

3.1.2 Streams per Connection

This column indicates the number of content streams required by the application. It is not a reflection of the requirement for 1-way or 2-way communication. It is assumed that all networked applications require 2-way communication.

3.1.3 1-Way Delay Considerations

1-Way Delay is the difference between the time a packet is sent by its source and the time the packet reaches its destination. Although for some technologies, this is a tightly specified value, for others it can vary widely according to the amount and types of data traffic. The column indicates where there are special considerations that need to be taken into account.

3.1.4 Round-Trip Delay Considerations

For applications that require bi-directional streams, or responses to a request, the total delay of both directions may be important.

3.1.5 Jitter Considerations

The variation in the delay from packet to packet

3.1.6 Sensitivity to PER / PLR (3 Levels)

PER is Packet Error Rate and is the rate at which errors in transmission/reception result in the rejection of a packet. PLR is the Packet Loss Rate and is equivalent to PER for our purposes. This column indicates if the application is highly, moderately or not sensitive to PER / PLR.

3.1.7 Security Considerations

There are many different security requirements ranging from encryption to render the data unreadable to unauthorized devices, to authentication which ensures that the device is what it says it is. There are also differing levels of security. This column provides some indication as to the types of security that an application may require.

3.1.8 Comments

The comment column is used to provide additional information for purposes of clarification.

Table 1 – QoS Considerations for Different Applications

Applications	Typical Payload Bit Rate per Stream	Streams per Connection (number)	1-way Delay Considerations	Round trip Delay Considerations	Jitter Considerations	Sensitivity to PER /PLR (3 Levels)	Security Cons iderations	Comments
Video for								
Watching Broadcast TV (MPEG2)	3-20 Mbps[1]	1	Important for channel changing	Not important	Part of delay, tradeoff with buffer size	High - Some errors can be handled by buffering with retransmission – tradeoff with throughput	May be subject to content control mechanisms (e.g. retransmission flag)	
Interactive TV, Video on Demand (MPEG2 stream, separate control data)	3-20 Mbps	1	Important for channel changing	Important for user interactivity (control information needs timely response)	Part of delay. Tradeoff with buffer size.	High for video stream (see note on Broadcast TV). Low for control data (assumes robust protocols e.g. retransmission, FEC)	MPEG2 stream may be subject to content control mechanisms Encryption for financial transactions	Assumes separate control data for interactivity
Premium channels, Pay Per View (MPEG2)	3-20 Mbps	1	May be important for channel changing	Not important	Part of delay. Tradeoff with buffer size	High (See note on Broadcast TV).	May be required for copy protection, etc.	
Internet Video	28.8k – 1500k bps	1	Not important	Not important	Part of delay. Tradeoff with buffer size	Low if buffered High if live or multicast	Unknown	
Privately generated video	3-30 Mbps (30 Mbps is for Digital Video)	1	Not critical	Not important	Not important	High - Some errors can be handled by buffering with retransmission – tradeoff with throughput	Important for privacy	
Videophone	144 kbps (for ISDN)	2	Important for human factors	Important for human factors	Part of delay. Sensitive due to 2-way communication	High	Important for privacy	Assume audio and video are multiplexed into 1 stream
Audio for								
Listening to radio, CD, MP3	128 kbps - 320kbps	1	Important for multi-room distribution	N.A.	Part of delay. Tradeoff with buffer size	High- Some errors can be handled by buffering with retransmission – tradeoff with throughput	May be required for copy protection	
Wireless Stereo Speakers	64kbps - 1.5Mbps	1	Very important for synchronization	N.A	Sensitive due to need for short delay	High	May be required for copy protection	Assumes one stream, speaker will extract its channel
Home Theater Audio	384kbps – 4.5 Mbps	1	Very Important for synchronization	N.A.	Sensitive due to need for short delay	High	May be required for copy protection	Assumes one stream, speaker will extract its channel

[1] EIA775 has an option for multiplex streams up to 40 Mbps

Applications	Typical Payload Bit Rate per Stream	Streams per Connection (number)	1-way Delay Considerations	Round trip Delay Considerations	Jitter Considerations	Sensitivity to PER /PLR (3 Levels)	Security Cons iderations	Comments
Telephony	64 kbps	2	Important for human factors	Important for human factors	Part of delay. Sensitive due to 2-way communication	High	Important for privacy	
Data for								
Command/control	~8 kbps	N.A.	Important for resource management	N.A.	Part of delay. Tradeoff with buffer size	Low, uses retransmission	–Unknown	
Game Controllers	8kbps	N.A.	Important for human factors	Important for user interaction	Sensitive due to need for short delay	High	Unknown	
Web browsing	~28.8 kbps – 1500kbps	N.A.	Not critical	Not critical	N.A.	Low, uses retransmission	May need encryption	Includes fax, email and financial transactions
Web hosting	28.8 kbps – 1500k bps	N.A.	Not critical	Not critical	N.A.	Low, uses retransmission	May need encryption	External access, internal hosting
Instant Messaging	28.8 kbps or greater	N.A.	Important for human factors	Important for human factors	N.A.	Low, uses retransmission	May need encryption	May include text and pictures
Interactive games	~8 kbps	N.A.	Important	Important	N.A.	High	May need encryption	Interconnected game consoles
Large file transfers (Photography, printing)	Limited by network congestion	N.A.	Not important	Not important	N.A.	Low, uses retransmission	May need encryption	

Table 1 - QoS Considerations for Different Applications

4 Survey of Wireless Technologies

Currently Table 2, Candidate Technologies, is under construction. The working group is examining parameters associated with wireless technologies and then organizing and defining the parameters such that the application developer can understand the impact of a technology choice on their application. Completion of Table 2 is expected for fall of 2003. Perhaps the most difficult aspect of Table 2 will be populating the cells with meaningful information. In many cases, there are no standards for relating the wireless parameters to a home environment. For example, the parameter, “coverage area,” if defined in open space will have no relation to a home or apartment dwelling configuration.

Table 2 – Candidate Technologies

Technology / Attribute	DECT DPRS	IEEE 802.11g	IEEE 802.11a	ETSI HiperLAN/2	IEEE 802.15.3	IEEE 802.15.4	IEEE 802.15.1	HiSWANa	IEEE 802.11b	Magis AIR5	Comments
Frequency Band											
USA											US Unlicensed Band Only
Europe											European Unlicensed Bands only
Japan											Japanese Unlicensed Bands only
# of RF Channels											
USA											
Europe											
Japan											
Bandwidth per RF Channel/MHz											
USA											
Europe											
Japan											
Dynamic RF Channel Selection											
Transmit Power (EIRP)											Per appropriate government regulations
USA											
Europe											
Japan											
Coverage Area											Note - 4/29/03: Need to review how to specify channel characteristics for coverage area
Link Rate											Theoretical maximum
Throughput (Async Service)											Ideal conditions (no physical and electrical interference, also no traffic congestion)
Throughput (Isoch Service)											Ideal conditions (no physical and electrical interference, also no traffic congestion)

	DECT DPRS	IEEE 802.11g	IEEE 802.11a	ETSI HiperLAN/2	IEEE 802.15.3	IEEE 802.15.4	IEEE 802.15.1	HiSWANa		Magis AIR5	Comments
Delay (1 Way)											Note - 4-17-03: As in a ping
Minimum Delay (Isoch Service)											Notes - 4-17-03: For technology under ideal conditions (not including delays added by the application, and with no other traffic)
Maximum Delay (Isoch Service)											Notes: 4-17-03: Assumes the packet is at the beginning of the transmission, depends on number of users, easier to determine for asynch than isoch / may need to use ave. maximum
Minimum Delay (Async Service)											Notes - 4-17-03: For technology under ideal conditions (not including delays added by the application, and with no other traffic)
Maximum Delay (Asynch Service)											Notes: 4-17-03: Assumes the packet is at the beginning of the transmission, depends on number of users, easier to determine for asynch than isoch / may need to use ave. maximum
Jitter (Isoch Service)											The variation from the expected packet time of arrival
Jitter (Async Service)											
Delay (Round Trip)											Notes - 4/17/03: Result of a "ping" like message
Minimum Delay (Isoch Service)											
Maximum Delay (Isoch Service)											
Minimum Delay (Async Service)											

	DECT DPRS	IEEE 802.11g	IEEE 802.11a	ETSI HiperLAN/2	IEEE 802.15.3	IEEE 802.15.4	IEEE 802.15.1	HiSWANa		Magis AIR5	Comments
Maximum Delay (Asynch Service)	-										
Error Rates											Note - 4/22/03: Need to review how to specify channel characteristics for BER, PER including free space, distance, etc.
Bit Error Rate											
Packet Error Rate (After FEC)											
Security											Note - 4/22/03: Only security that is built-into the technology
Authentication											Note - 4/22/03: Specify method used
Encryption											Note - 4/22/03: Specify method used
Native Isoch Support											Yes or no entry
# of Logical Channels											Protocol maximum
# of addressible nodes											
Co-location capable											
Parameterised QoS											
Priority Classes											
Convergence Layers											
Ethernet											
IEEE1394											
Mobility											
Portable											
Mobile											
Co-existence with other WLANs											
PWR Consumption											
Commercially											

	DECT DPRS	IEEE 802.11g	IEEE 802.11a	ETSI HiperLAN/2	IEEE 802.15.3	IEEE 802.15.4	IEEE 802.15.1	HiSWANa		Magis AIR5	Comments
Available											
Overall System Complexity (PCI)											
Overall Sys Complexity (Dedicated)											

Table 2 - Candidate Technologies