Wireless for PAN and LAN

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Wireless for PAN and LAN

Agenda:

1. For what will wireless be used?

2. What specifications or characteristics are needed?

3. Which standards can address these needs?

4. What is the status of the standards and issues to be solved

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For what will wireless be used?

- Traditional' uses such as file transfer, web browsing and sending emails. These are characterised by user initiation and have defined ends. Typically they are between client and server, not peer to peer. But the server may just be a simple device like a light switch

- Ad-hoc data transfers between peer entities, user initiated. An example application is exchange of media files

- Always on, always connected services. These are new concepts for portable devices. They must not require user intervention, but are again not peer to peer

- Media streaming. Can be telephony, compressed music or video

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The characteristics of a wireless system are:

1. Raw data rate
2. Range
3. Scalability
4. Management overhead - does it need to be managed?
5. Latency before data transfers can start
6. Power consumption in real use cases
7. Size
8. Cost
9. Interoperability - does one buy both ends at the same time?
10. Quality of Service

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Standards to be considered:

1. Bluetooth
2. 802.11b
3. 802.11a and g

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Bluetooth:

1. Raw data rate	v1.1 is 1Mbit/s, v1.5 will be 3Mbit/s
2. Range	30m - 100m in office, 100 - 300m open site at full rate,
3. Scalability	Virtually unlimited density
4. Management overhead	None
5. Latency	Traded with power consumption
6. Power consumption	100mW peak, 1mW for 1 sec latency, 10mW for 20ms
7. Size	100mm^2 module, 60mm^2 in a cell ‘phone
8. Cost	$3 in 2004
9. Interoperability	now very good
10. Quality of Service	For voice. Unproven for data
11. Frequency band	2.45GHz

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802.11b

1. Raw data rate	1 to 11Mbits/s depending on range
2. Range	30m - 100m in office, 100 - 300m open site
3. Scalability	Near unlimited density
4. Management overhead	Needs a managed access point
5. Latency	Not trade-off yet deployed, so very short
6. Power consumption	600mW, with no trade-off with latency yet proven
7. Size	2000mm^2
8. Cost	$10 in 2004
9. Interoperability	now very good
10. Quality of Service	None
11. Frequency band	2.45GHz

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802.11a,g

1. Raw data rate	up to 54 Mbits/s depending on range
2. Range	10m - 30m in office, 100 - 300m open site
3. Scalability	Near unlimited density
4. Management overhead	Needs a managed access point
5. Latency	No trade-off yet deployed, so very short
6. Power consumption	1000mW, with no trade-off with latency yet proven
7. Size	4000mm^2
8. Cost	$15 in 2004,
9. Interoperability	unproven
10. Quality of Service	None yet
11. Frequency band	g is at 2.45, a at 5GHz

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   - 4.1 - Bluetooth
   - 4.2 - 802.11

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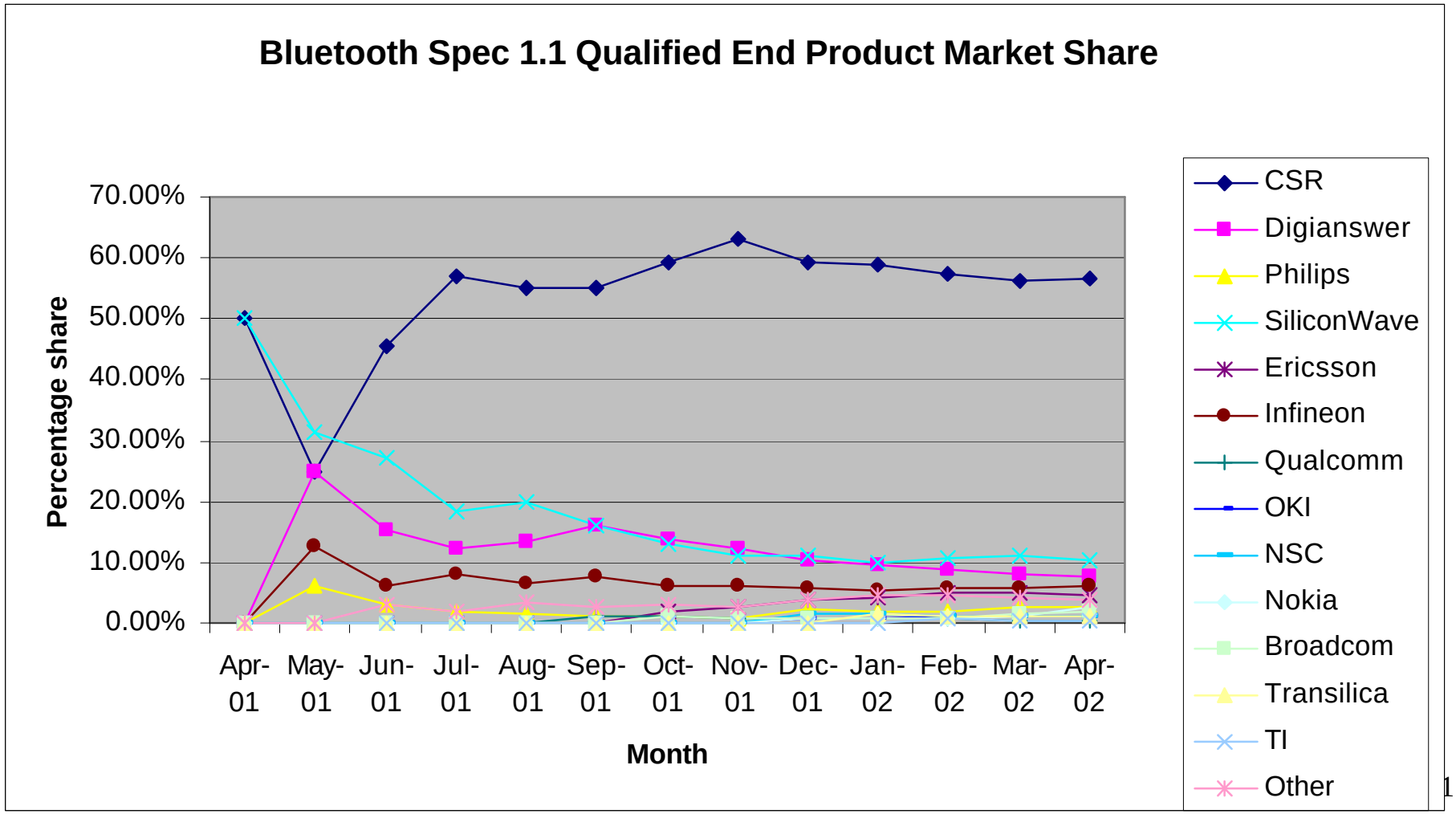
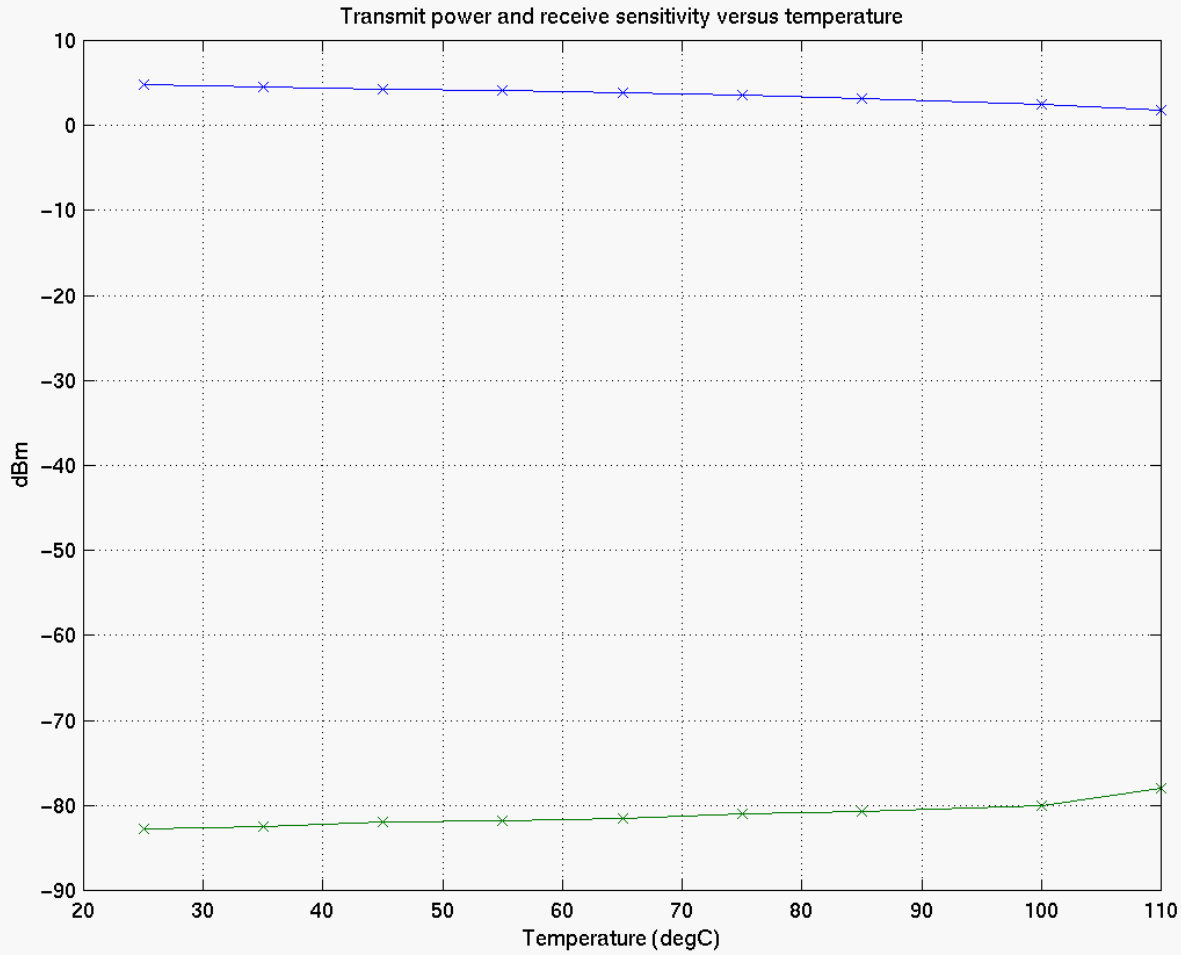
Status of Bluetooth

- The baseband for Bt 1.1 is stable and there are almost no issues
- Performance is not an issue, and the only serious players are all single chip on CMOS
- The largest problem by far is application software:
  - The use cases are much more complex than LAN or GSM
  - XP now supports Bluetooth, as do Apple, but it has taken ages and is still not very good
  - There are a proliferation of ‘profiles’, and many are rather poor
  - The IP based PAN profile is still in draft, and won’t be widely deployed until 2003
- Nonetheless there were 25 million shipments in 2002 and expect to see 80 million shipments in 2003
- There are no IP vendors with any market share!

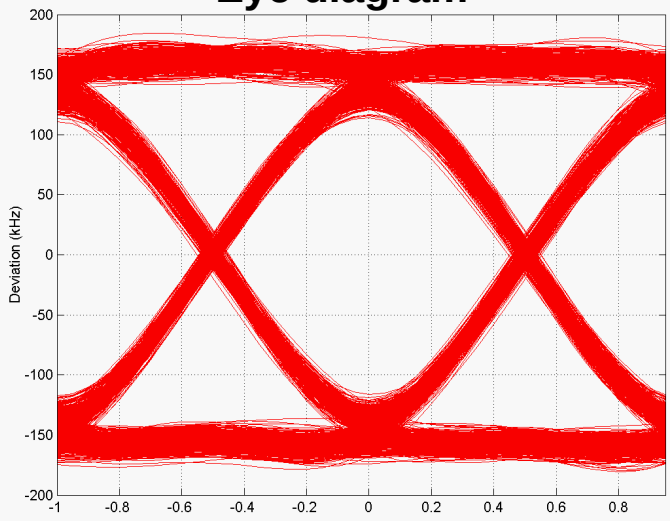
Market share by qualified end products



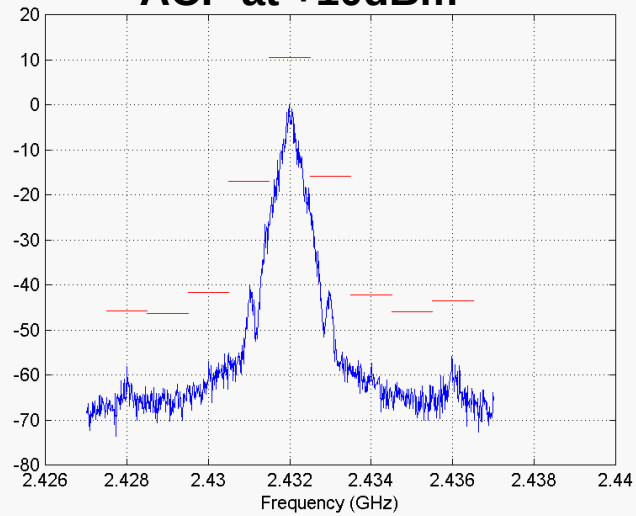
RF performance is not an issue



Eye diagram



ACP at +10dBm



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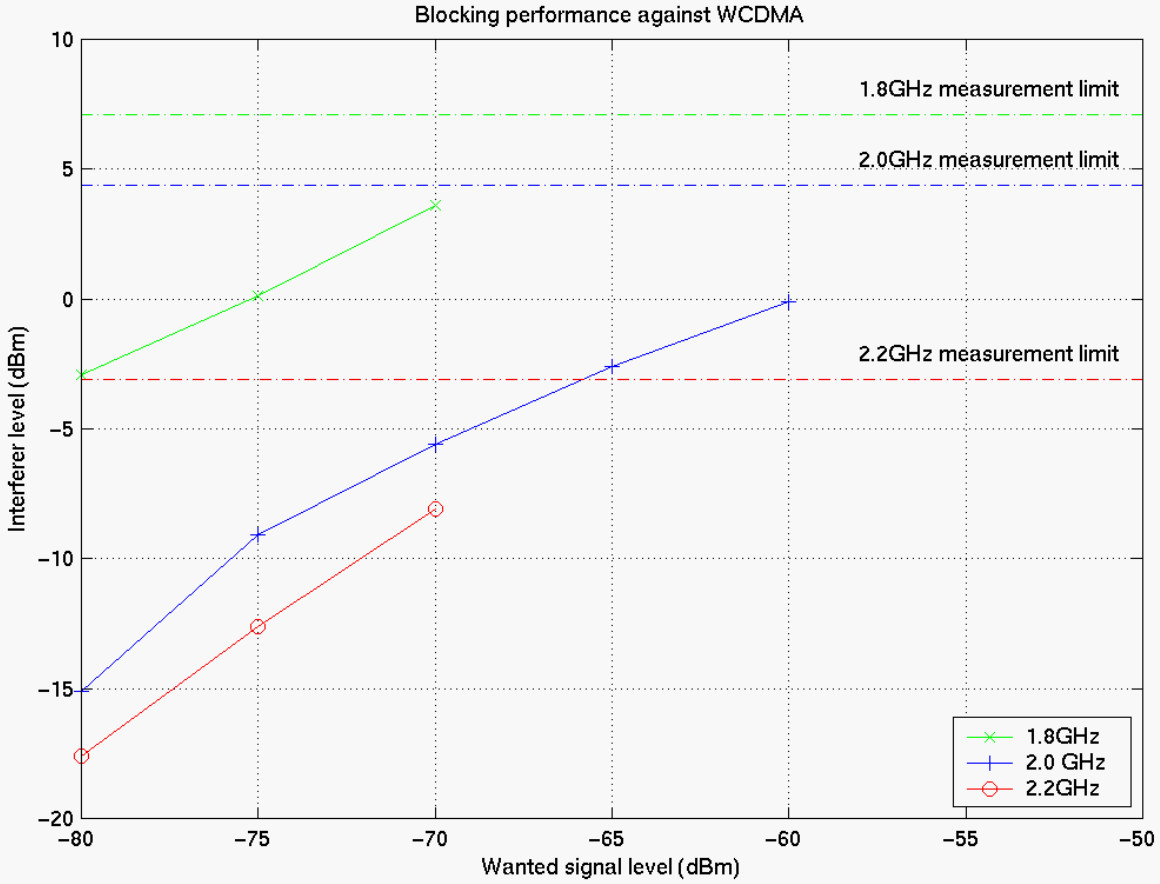
Status of Bluetooth

- The performance battles are now:
  - Cost: There is relentless price pressure to get below $3. Implementations are in 0.18u CMOS, with 0.13u becoming economic in 2004
  - Power consumption: 50mW during a voice call must fall to 30mW by end next year, 1mW today for connectable standby must halve in the same time
  - cell ‘phone compatibility, especially with WCDMA/UMTS ‘phones
- More of the Bluetooth IC vendors are taking responsibility for upper layers and providing complete products on one chip: we see today Keyboards, Mice and headsets with only one chip - no other chips required
- The coming push (at least for CSR) is into industrial and consumer products via web servers on the one chip, so the central heating controller’s MMI is a web page viewed from a lap-top, PDA or web tablet

Illustration of Blocking performance of Bluetooth



Some examples of products - computer space

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Status of 802.11 - WARNING a view that may not be widely shared!

- 802.11b has been around for many years, and at last has taken off
- I expect about 15 million shipments in 2002 and expect to see 25 million shipments in 2003
- This is entirely for computer LAN access, where power consumption is irrelevant
- The secret of the success is because it pretends to the computer to be ethernet, so it is not dependent on new PC software, and it is stable.
- However to make it suitable for battery powered items or to support QoS are such that it will become a different standard and its advantage of no special PC support and stability will both be thrown away
- The RF specifications are appalling, even supposing most manufacturers meet even these (which they don't!)
- There is no way 802.11b, as currently implemented, is going into cellular 'phones, nonetheless I expect 802.11 systems in mobiles in 2005 - so what is required?

RF compatibility

- The spectral purity of 802.11b radios is very poor, in fact barely legal, and severely limits the possibility for multiple networks to coexist even when they do use different notional channels
- This means that new radios are required anyway, with better phase noise and much more accurate modulators. This effectively means that one might as well do a radio suitable for OFDM with 64QAM, so the next generation of radios can be expected to support 802.11a and g as well as b.
- Most 802.11b from ends block at -30dBm to -25dBm out of band. This has to improve by at least 15dB for the ceramic filters to be possible to make before compatibility with cell 'phones is achieved. This favors all CMOS designs
- I expect to see lower output power versions being produced, with perhaps +3dBm mean output power so no external LNA, PA or switches are needed (CSR has implemented a dual band, dual mode 802.11a/b/g radio on 0.18u CMOS in under 6mm^2, and I must suppose others are doing similar designs)

Illustration of spurious emissions from 802.11b

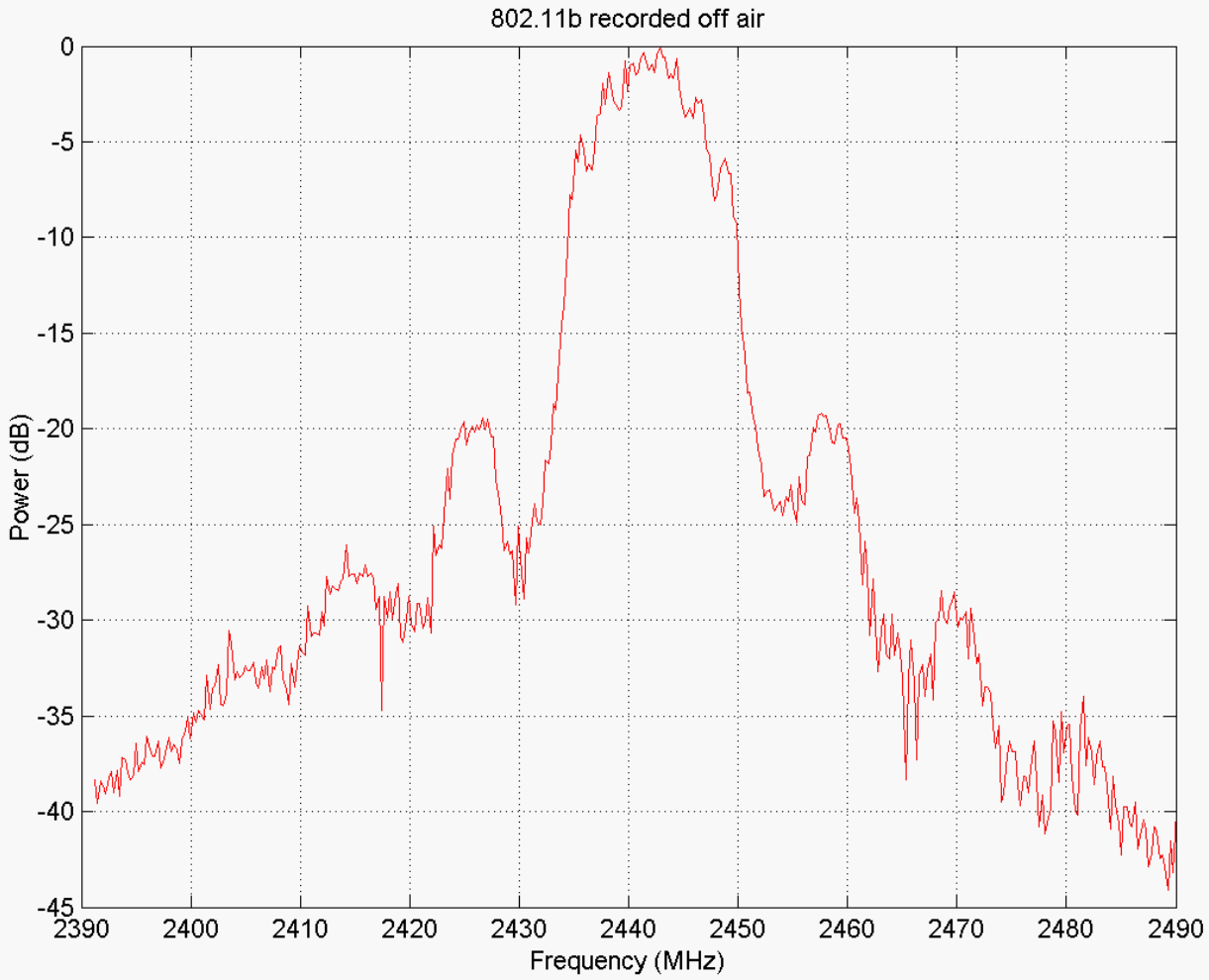
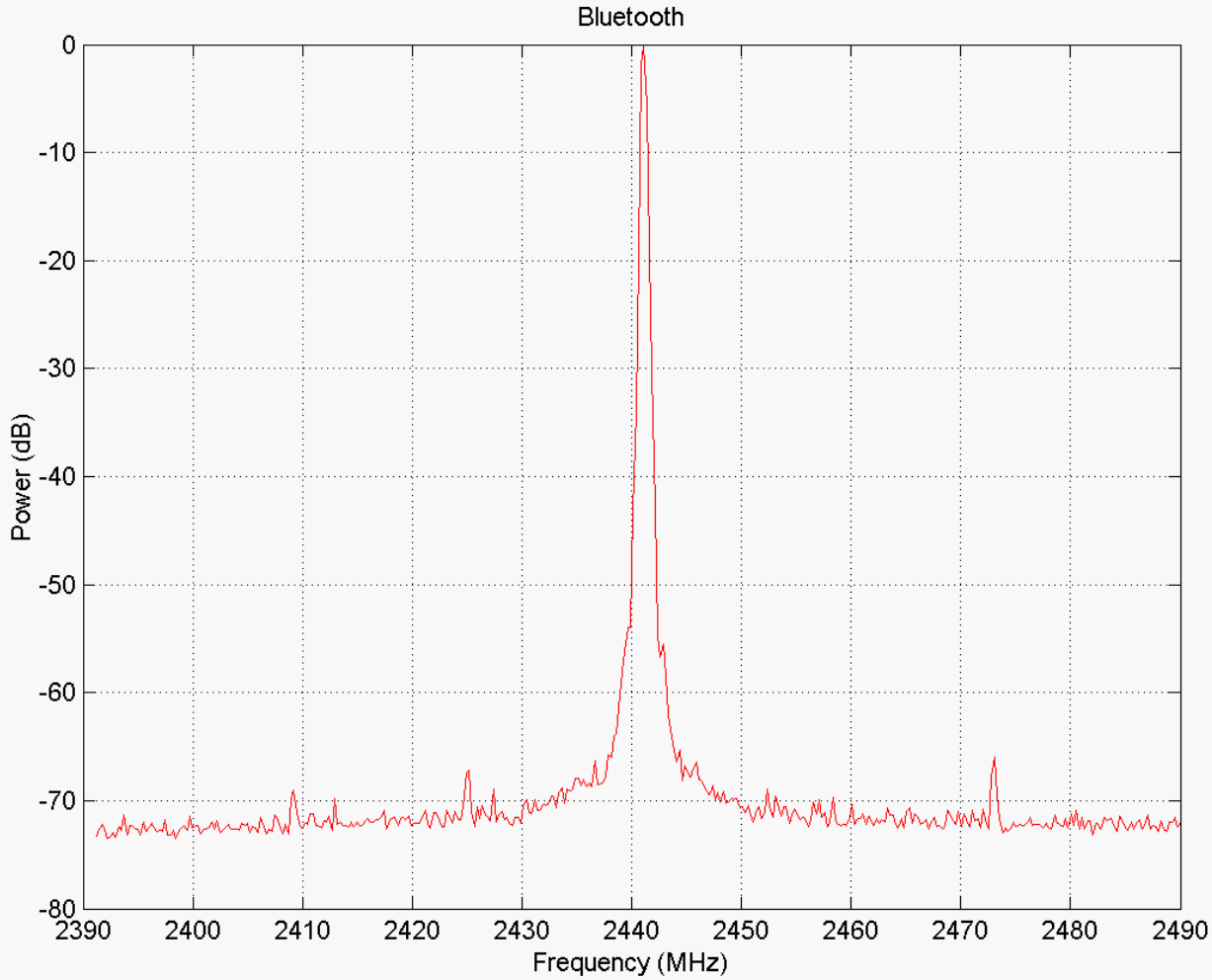


Illustration of spurious emissions from Bluetooth - note different vertical scale



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- The MAC split between the OS and the NIC will change:
- Functions exported to the PC's CPU are the memory intensive functions, the QoS and encryption
- Co-design of the QoS, power management and media content compression are vital for good cost and power consumption tradeoffs
- If used for media distribution or sale then security and water marking must be co-designed
- These requirements have destabilised the 802.11a standard
- Many competing proposals have been put to the IEEE, and the process is in disarray. Recent press has, quite rightly, been very hostile to the IEEE.
- No convergence is expected until late 2003 and no mass roll-out is expected until mid 2004
- Nonetheless an IP based not ATM based system will triumph, and Hiperlan seems to have lost its support

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- The IEEE has not got the structures to force a standard, and this leads to very slow evolution and fragmentation. It is now suffering (quite deservedly) adverse publicity as a result. 2 weeks ago the IEEE president issued an open letter complaining about the number of proprietary and incompatible variants
- The JEDEC attempt to standardise interfaces between chips does not address the MAC functionality problems at all (to be fair, nor is it supposed to). I do not see the point of perpetuating an old fashioned system partition - remember what happened to BlueRF
- A new body is required to create a standard. I believe it should be similar to the Bluetooth SIG, and must include:
  - system companies, rather than being dominated by chip producers
  - consumer equipment, not entirely computer companies
  - the promotion of ‘unplug fests’ as was done for Bluetooth

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So what do the characteristics need to be?

1. Standard	Only multi-mode a/b/g chips will survive
2. Raw data rate	20Mbits/s is required, so the ETSI BRAN OFDM radio
3. Range	10m - 30m in office/domestic, 100 - 300m open site
4. Scalability	Near unlimited density
5. Management overhead	An access point is allowable provided only 1.5x cost
6. Latency	Must be tuneable, in 1sec to 10msec range
7. Power consumption	200mW peak, with trade-off against latency to get 10mW
8. Size	200mm^2 or it won't go in cameras or cell 'phones
9. Cost	$8 in 2004
10. Interoperability	The QoS and low power modes will need 'unplug-fests'
11. Quality of Service	Vital to present connection oriented video streams