HIPERLAN 1: the 23 Mbps Wireless LAN

How compatible with IEEE Project 802?

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Presentation agenda

- Introduction to HIPERLAN, what is it?
- The HIPERLAN 1 MAC
- The HIPERLAN 1 CAC (Channel Access Control), a possible link between the 802.11 MAC and the HIPERLAN 1 PHY?
- The HIPERLAN 1 PHY
- Question time

Introduction

- Why Wireless?
- What facilities must we have from a WLAN?
- What facilities would we like from a WLAN?
- What is HIPERLAN?
- What does HIPERLAN 1 give us?
- Why such a high performance?

Why Wireless?

- Convergence of communications and computing into a single device
- Lowest overall network system cost in certain scenarios
- Alternative option for certain last drops on wired LAN
- Allows untethered working

What MUST we get from a WLAN?

- User data delivery (& close approximation to IEEE 802.x facilities)
- Forwarding
- Equitable multiple access
- Acceptable level of security
- Neighbourhood discovery
- Usable battery life
- Accommodation of the wireless medium issues

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What would we like from a WLAN?

- User priority system (for time-bounded services)
- Allowability of uncoordinated deployment, and non-centralised operation
- Allowability of ambulant usage
- Tiny implementation, compatible with PDA/HPC
- Support for extreme power-saving nodes
- Cheap units!

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What is HIPERLAN? (HIgh PERformance Radio LAN)

- Type I: distributed WLAN, 5 GHz
  (published European Standard: MAC and PHY)
  ... (the subject of this session)

- *Type II: W-ATM, 5 GHz, 1999?*
- *Type III: wireless remote access, WLL?, 1999?*
  5 or17 GHz
- *Type IV: very high rate wireless*
  infrastructure
  155 Mbps ATM, 2000?

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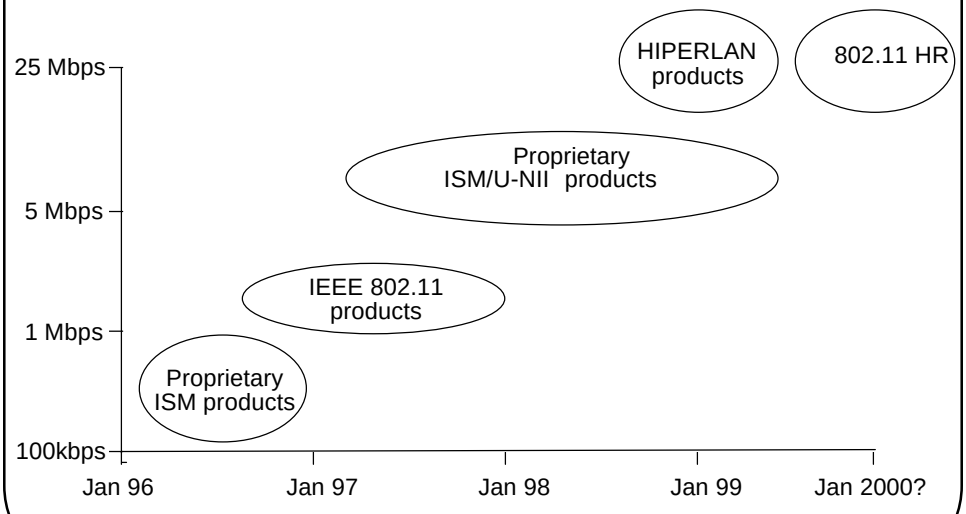
WLAN product introductions



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What does HIPERLAN 1 give me? (user perspective)

- On-Air Bit Rate 23.5294 Mbit/s
- Node Coverage 50 m typical
- Built-in Mobility PC type II format, Walking Speed use Europe-wide legality maybe USA too in future?
- No Fixed Infrastructure
- Overlapping HIPERLANs permitted
  - No Frequency Planning, no user license
- Connectivity to Wired Networks
  - Ethernet, Token Ring, ATM

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HIPERLAN 1 PC-card: Product perspective

- Antenna array system:
  - prismatic card extension
  - broadband HIPERLAN/U-NII
- 5 GHz RF: SiGe or GaAs front-end
- IF: integrated Si
- Converters: current technology
- Modem: integrated digital state machines
- Protocol controller: hardware and microcontroller
- PC-card interface

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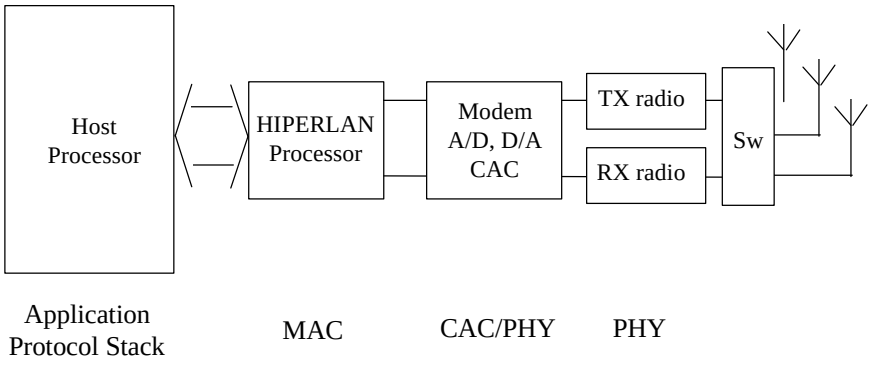
HIPERLAN: terminal architecture



Does HIPERLAN 1 meet WLAN needs?

- Service definition based on ISO 15 802-1
- Statistical approximation to time-bounded services
- “Forwarders”, “Power-savers”, “Power-saver supporters”, Ultra-low duty cycle allowable, lowest power (unequalised receiver) mode for monitoring traffic
- *Ad-hoc* deployment, with centralised operation allowable as merely one special case.
- Highly efficient, equitable priority and contention resolution on a *per-node* basis
- PC-card implementation, $120 BOM

When does HIPERLAN 1 offer these?

- Right now!
- Functional specification published October 1996, ETSI ETS 300 652
- Conformance testing specification (radio & protocol), ETSI ETS 300 836
- http://www.etsi.fr
- Compliant products expected during 1998

Why such a high performance?

- Delivery at MAC SAP is 19 Mbps, but this is shared between network stations
- It's not just high bit-rate that's needed, it's also low latency ...
  - ... and low delay variance
- ... and satisfaction of user requirements raised by
  - experience with wired LANs
  - "need" for multimedia, colour and movement
- the future is broadband
- the trend is to decentralised *ad-hoc* networking

The HIPERLAN 1 Channel Access Control Sub-layer

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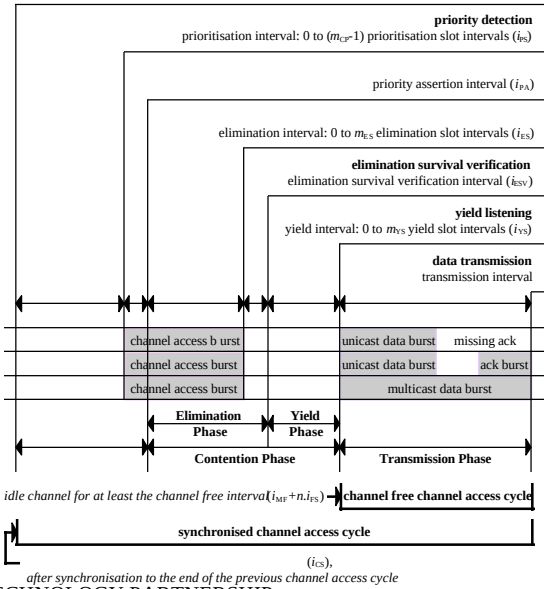
Reminder : IEEE 802.11 Channel Access

- Listen Before Talk protocol
- Provides Data Transfer Servic
  - 2 Control Functions defined (DCF & PCF)
  - Acknowledged Unicast, un-Acknowledged Multicast transfers
  - Non-preemptive hieracrchical independence
  - 4 priority levels defined via Inter-Frame Spacing
    - SIFS, PIFS, DIFS, EIFS
- Secondary transfer functions enumerated for many specific cases
  - e.g. Segmentation, Virtual busy, Contention Free etc.
- Exponential, slotted backoff after collision

HIPERLAN CAC Service

- Implements MAC facilities over the shared HIPERLAN channel
- Priority Access Scheme - EY-NPMA
- Hierarchical Independence of Priorities
- Contention Resolution within Priority Level
- Synchronized & Channel Free accesses
- Channel Permission management

HIPERLAN Channel Access



HIPERLAN Transfer Service

- Global Channel Access Mechanism in 3 phases
  - Prioritization
  - Contention
  - Transmission
- Hidden Elimination
- Data coded in Low Bitrate & High Bitrate parts

Contention Resolution

- IEEE 802.11 defines an exponentially increasing slotted backoff mechanism
- HIPERLAN defines an exponetial probability distribution for the extension stage of the priority assertion signal, followed by a linear probability distribution function for the yield stage. (Designed for 3.5% residual collision rate.)
- HIPERLAN contention resolution algorithm is part of the access mechanism

HIPERLAN Channel Permission Function

- HIPERLAN spectrum divided into 5 channels
  - 5.15 - 5.25 GHz, 3 channels
  - 5.25 - 5.30 GHz 2 Channels
- Higher frequency channels are available at national discretion
- Mechanism needed to prevent illegal transmissions
- Channel Permission function

CAC Summary

- HIPERLAN CAC Service provides the transfer service to the HIPERLAN MAC
- Priority and contention resolution coded into a single active signal
- HIPERLAN CAC and 802.11 MAC Transfer Services share much in common
  - non-pre-emptive hierarchically independent priorities
  - Ack'd unicast and un-Ack'd multicast transmissions
- Differs in Contention Resolution approach
  - 802.11 backoff
  - HIPERLAN probabilistic signalling in LBT access mechanism

The HIPERLAN 1 PHY layer

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Spectrum: USA and Europe

- U-NII bands
  - 5.15 GHz to 5.25 GHz, 50 mW PEP, less than 2.5 mW/MHz, +6dBi ant. gain
  - 5.25 GHz to 5.35 GHz, 250 mW PEP, less than 12.5 mW/MHz, +6dBi ant gain
  - 5.725 GHz to 5.825 GHz, 1W PEP, less than 50 mW/MHz, +6dBi ant. gain
- HIPERLAN 1 band
  - 5.15 GHz to 5.25 GHz throughout Europe
  - 5.25 GHz to 5,3 GHz extensions on national bases
  - allowed transmit power, 1W EIRPEP in both bands, HIPERLAN modulation
- HIPERLAN 1 in U-NII (from Tx in-band spectrum aspect)?
  - 1W EIRPEP device is illegal
  - 100 mW EIRPEP device (class B) legal if rebanded to 5.7 GHz U-NII
  - 10 mW device legal throughout U-NII

HIPERLAN channels & modulation

- 5 channels spaced at 23.5294 MHz
  - wide band-edges left to allow simple Tx filtering
- Cellular spectrum sharing model does not apply
  - HIPERLANs will share spectrum equitably
- High-rate and low-rate modulation specified
- Single carrier high-rate modulation
  - GMSK, BT=0.3
  - 23.5294 Msymbol/s
  - constant envelope: cheaper, more efficient Tx PA
  - allows equalisation as if a linear scheme

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Low-bit-rate modulation

- the initial content of all HIPERLAN 1 bursts
- MSK at 1/16 of full data rate
- transmitted at full power (hence higher spectral density than for high-rate modulation)
- allows power saving in the receiver
  - carries length and destination address information
  - can be received without equalization

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High bit-rate reception problems

- Equalization of high rate signalling
  - antenna diversity and directivity is possible at 5.2 GHz in PC-card format
  - HIPERLAN provides a long training sequence
  - antenna selection can be performed during training
  - designer can balance speed of training, antenna complexity, equalizer
- Battery life
  - low bit-rate header provides information without receiver equalization
  - power-saving modes are supported
  - transmit power is reasonable for a usable coverage range
  - constant envelope transmit modulation means less backoff in transmitter
- Channel stability
  - HIPERLAN 1 burst duration is limited
  - for ambulant motion, the channel can be considered as stable
  - symbol clock is tightly constrained to RF carrier
  - hence receivers need only track the carrier, and not retrain during bursts

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Co-existence with IEEE 802.11 HR?

- Co-existence raises the possibility of hybrid WLANs
- U-NII band includes HIPERLAN 1 band
- targeted products and users for 802.11 and HIPERLAN 1 align

BUT

- HIPERLAN 1 Tx power level is above U-NII limits for some devices, though class A (10 mW) is legal
- HIPERLAN 1 band occupancy protocol is known
  U-NII sharing rules not yet settled?

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Interoperability with IEEE 802.11 HR?

- would provide “world-” products
- HIPERLAN 1 standard is complete and available in USA
- HIPERLAN 1 MAC services align to IEEE/ISO

BUT

- Certain 802.11 MAC services are unavailable in HIPERLAN 1, and vice versa

HIPERLAN 1 PHY derivative usable as IEEE 802.11 HR?

- HIPERLAN 1 fits data rate goal of 802.11 HR
- U-NII band includes HIPERLAN 1 band
- HIPERLAN 1 MAC services are comprehensive

BUT ???

- this is a topic for discussion in 802.11 PHY group meeting Montreal, 11/11/97
  - (the eleventh hour?, actually the afternoon session)


Question time
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Time for the bar
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