

## Tutorial on 802.11 to 802

Prepared by Vic Hayes, Chair IEEE P802.11  
One of the founders and chair from the beginning  
(September 1990)  
Lucent Technologies

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## Outline (1)

- Requirements
- MAC
  - Wireless Architecture and MAC architecture overview
  - Basic Access mechanism and Frame formats
  - MAC Management and mobility provisions
- PHY
  - Spectrum selection
  - Frequency Hopping PHY
  - Direct Sequence PHY
  - Infrared PHY

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## Requirements

- PAR
- Study the environment and applications
- Functional Requirements

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## Requirements (PAR)

- Project Authorization Request (PAR)
  - Title: Standard for Wireless Medium Access Method (MAC) and Physical Layer (PHY) Specifications
  - To develop a Medium Access Control (MAC) and Physical Layer (PHY) specification for wireless connectivity for fixed, portable and moving stations within a local area.
  - To provide wireless connectivity to automatic machinery, equipment or, stations that require rapid deployment, which may be portable, or hand-held or which may be mounted on moving vehicles within a local area.
  - To offer a standard for use by regulatory bodies to standardize access to one or more radio frequency bands for the purpose of local area communication.

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## Requirements (802.11)

- Type of medium
  - The goal is that the MAC shall support PHYs using electromagnetic waves through the air (i.e.. radio waves as well as infra-red or visible light).
  - PHY layer suitable for use with the electromagnetic frequency spectrum as described in the following paragraph will be defined with this standard. If evidence of need and sufficient interest exists other PHY layers will be considered at a later time.
- Supported Stations
  - The standard shall support stationary stations, movable stations, and mobile stations moving at pedestrian and vehicular (local premises environment) speeds. This is to be implemented with one PHY if feasible.

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## Requirements (802.11)

- Environment
  - Because the range of wireless transmission / reception may be smaller than the physical coverage area desired, a distribution system designed to provide range extensibility will be addressed as part of this standard.
  - The standard will include support of the following:
    - Basic Service Area (BSA) in which each station can communicate with any other station in the BSA.
    - Extended Service Area (ESA) in which each station can communicate with any other station via the defined and managed Distribution System.
  - Stations which interoperate in both BSA and ESA shall be defined if feasible.

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## Requirements (802.11)

- Possible target environments include:
  - in buildings and other premises such as offices, financial institutions, shops, malls, small and large industry, hospitals and residences,
  - outdoor areas such as parking lots, campuses, building complexes and outdoor plants and storages.
  - Note: The definition of performance classes within a PHY may be necessary to support environments with benign or hostile characteristics.
- Supported service
  - The Wireless MAC shall support both connectionless service as defined in the MAC Service definition at rates between 1 and 20 Mbit/s as well as a service supporting packetized voice.

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## Requirements (802.11)

- Compatibility requirements
  - The specification shall meet the following standards and documents:
    - the IEEE P802 Functional Requirements including section 5.6.1 (in version 6.5) as defined below:
    - "5.6.1 The MAC Service Data Unit (MSDU) loss rate shall be less than  $4 \times 10^{-5}$  for an MSDU length of 512 octets."
  - A minimally conformant IEEE P802.11 network will meet all of the P802 requirements except that 5.6.1 will be met at least 99.9 % of the time on a daily basis, in 99.9 % of the total geography of the service area.
  - IEEE P802.11 will define approaches to allow a minimally conformant network to achieve full conformance over the total geography of the service area.

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## Requirements (802.11)

- Data Service Types:
  - 802.11 will provide two classes of MSDU delivery service:
    - 1) An Asynchronous MSDU delivery service.
    - 2) A Time-bounded MSDU delivery service.
  - All 802.11 implementations will support the Asynchronous class service.
  - Stations using the Asynchronous and/or Time-bounded service must coexist within the same BSS.
- MAC / PHY interface:
  - A single MAC will be used to support multiple PHYs.

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## Requirements (802.11)

- Note: To make this purpose feasible, this PAR also authorizes IEEE P802 to petition or provide comments to regulatory bodies worldwide (e.g.. the FCC in the USA, the Department of Communications in Canada, the RF agency of the Department of Trade and Industry in the UK and the Radio Frequency Commission of the CEPT of Europe)

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## MAC

- Wireless Architecture and MAC architecture overview
  - Greg Ennis, consultant to Symbol Technologies
  - member since May 1993
- document 96/49B

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## MAC (2)

- Basic Access mechanism and Frame formats
  - Wim Diepstraten, Lucent Technologies
  - member since November 1991
- MAC Management and mobility provisions
  - Phil Belanger, Aironet
  - member since July 1992
- document 96/49C

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## PHY Introduction

- Current draft supports 3 PHY specifications
  - 2 for radio
  - 1 for Infrared
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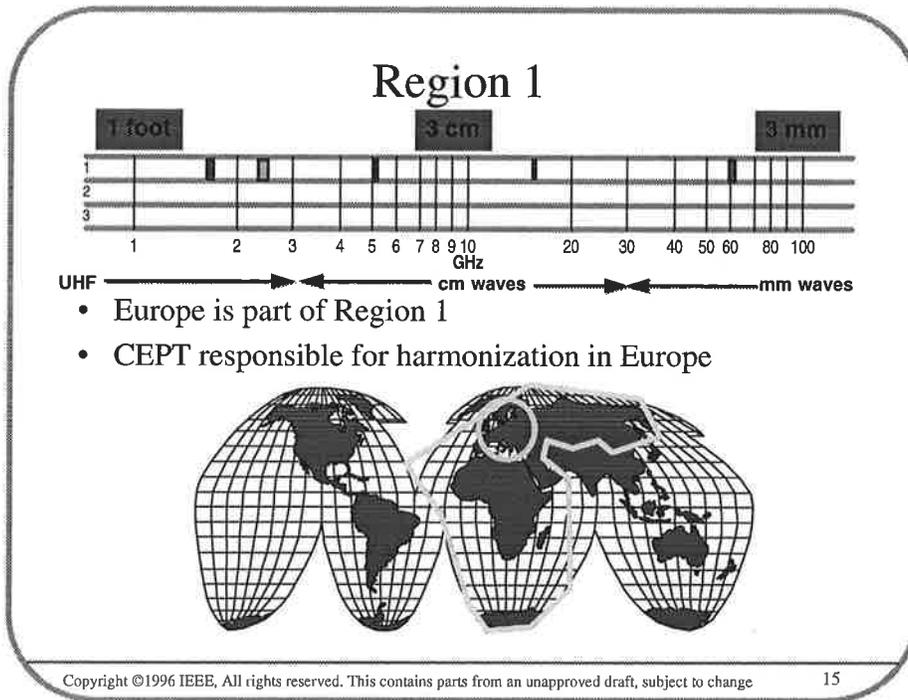
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## Radio Regulations

- Radio spectrum is a scarce resource and needs to be regulated
- Responsibility of local Administration
- International Regulations are the responsibility of the International Telecommunications Union, Radiocommunication Sector
  - Old name is CCIR (International Radio Consultative Committee)
  - Membership by Administration (or through administration)
- Main decisions made in the Radiocommunication Assemblies
  - Old name World Administrative Radio Conference (WARC)
    - Last one held in 1992
    - next one planned for 1995

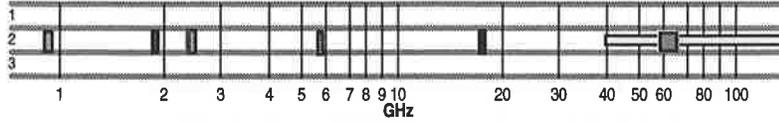
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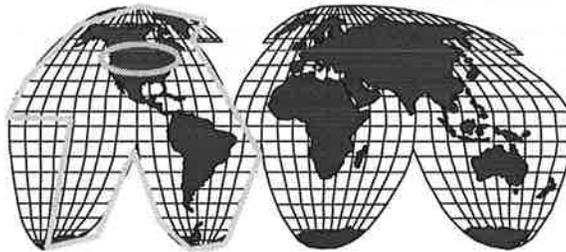


- ### Region 1
- ■ Allocation for DECT, 1.880 - 1.900 GHz
    - Digital European Cordless T(elephone)elecommunications
  - ■ Allocation for RLANs of 100 MHz in the 2.45 GHz band, T/R 10-01
    - top part (2.4835 - 2.500 GHz) may be withdrawn for satellite service
  - ■ Allocation for HIPERLAN, 100 + 50 MHz in 5.2 GHz area and 200 MHz in 17 GHz area, T/R 22-06
    - High Performance European radio LAN
  - ■ Allocation for RLANs in 61.0 - 61.5 GHz, T/R 22-03
  - 915 MHz band has been allocated to GSM (Groupe Speciale Mobile)
  - Some persons thinking about spectrum auctions as in USA
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## Region 2



- USA is part of Region 2
- FCC is the agency for regulation in USA



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## Region 2

- **FCC Part 15 rules allow for use of Spread Spectrum devices:**
  - 902 - 928 MHz also in Canada and Mexico
  - 2.4 - 2.4835 GHz also in Canada
  - 5.725 - 5.875 GHz
- **Unlicensed PCS, 1.910 - 1.930 GHz**
  - 10 MHz for voice applications (1.920-1.930 GHz)
  - 10 MHz for data applications (1.910-1.920 GHz)
  - needs to be cleared first
  - relocation to be paid by new users
    - definition of users unclear for non-licensed applications
    - conditionally designated to UTAM, Unlicensed (ad-hoc committee) for 2 GHz microwave Transition And Management
- **Unlicensed PCS, 2.390 - 2.400 GHz**

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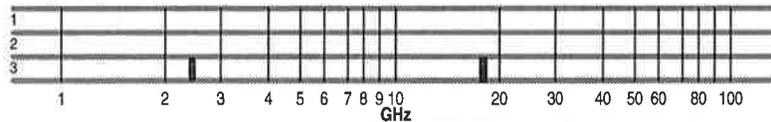
## Region 2

- Notice of Proposed Rulemaking for above 40 GHz allocation
  - 8.5 GHz for unlicensed services 
    - includes LANs, vehicle radar systems to avoid collisions
  - 5 GHz in a single band: 59-64 GHz
    - additional 3.5 GHz in 7 bands between 71 and 153 GHz
  - 7.3 GHz for licensed services
    - 3 GHz in two bands, 40.5 - 42.5 GHz and 47.2 - 48.2 GHz
    - 4.3 GHz in 7 bands between 71 and 153 GHz
- ■ Licensed band for data communications, 18.8 - 19.2 GHz

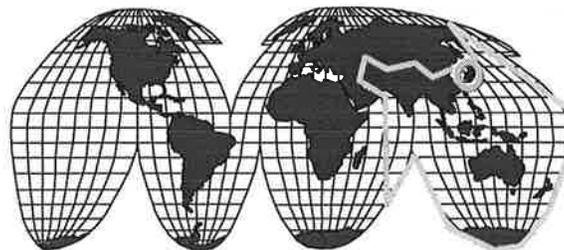
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## Region 3



- Japan is part of Region 3



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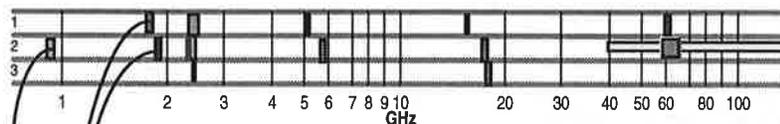
### Region 3

- Allocation in Japan for RLANs 2.471 - 2.497 GHz
- Many other countries in Region 3 adopting the 2.4 - 2.5 GHz allocation for RLANs
- Allocations expected in the area of 17 - 19 GHz

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### Global View



- 915 MHz band is only available in Region 2
- 1.9 GHz allocations in US and Europe differ in ruling:
  - US
    - spectrum etiquette (co-existence standard)
    - needs to be cleared from Microwave point-to-point links
    - clearing will be done area by area
    - cost of clearing will be charged to devices (US\$ 20)
    - nationwide clearing will take apr. 5 years
    - peer-to-peer devices not allowed before nationwide clearance
  - Europe
    - DECT standard(interoperability standard)

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### Global View

- 2.4 GHz
  - available in many countries around the globe
  - IEEE P802.11 working on an interoperability standard for 1 and 2 Mbit/s datarate
  - disadvantages:
    - secondary status
    - microwave ovens
- HIPERLAN band
  - only in European part of Region 1

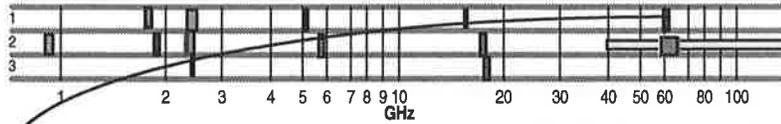
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### Global View

- 5.8 GHz band (ISM)
  - only available in the USA
- HIPERLAN
  - please turn to prior slide
- some channels in the 18.8 - 19.2 GHz band
  - only in the USA
  - subject to licensing
- 17 - 19 GHz band
  - only in Japan, rules unknown

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### Global View



- 61.0 - 61.5 GHz band
  - technology is too expensive yet
  - line of sight required due to properties of waves at this frequency
  - is in the Oxygen absorption band
    - limits coverage area

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### Availability of the 2.4 GHz band

US  
Canada



Australia  
China (\*)  
Hong Kong  
Indonesia (\*)  
Japan  
Korea  
Malaysia  
New Zealand  
Philippines (\*)  
Singapore  
Taiwan (\*)  
Thailand

Abu Dhabi (\*)  
Cyprus  
Israel  
Morocco (\*)  
Saudi Arabia  
South Africa  
Turkey (\*)

Austria  
Belgium  
Denmark  
Finland  
France  
Germany  
Iceland  
Ireland  
Italy  
Netherlands  
Norway  
Portugal  
Spain  
Sweden  
Switzerland  
UK  
Czech Republic (\*)  
Estonia  
Hungary  
Latvia (\*)  
Lithuania (\*)  
Poland (\*)  
Russia  
Ukraine (\*)

(\*) Certification in progress

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## PHY Frequency Hopping

- Frequency Hopping PHY
  - Naftali Chayat, Breezecom
  - member since September 1993
- document 96/49D

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## PHY Frequency Hopping

- Direct Sequence PHY
  - Jan Boer , Lucent Technologies
  - member since July 1992
- document 96/49E

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### Infrared PHY

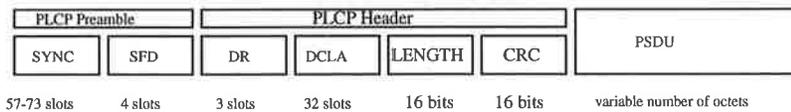
- No expert available at this meeting
- Nearly visible light
  - 850 nanometer to 950 nanometer range
- “Diffuse Infrared” transmission
  - the receiver and transmitter do not have to be aimed at each other and do not need a clear line-of-sight
  - range up to about ten meters
  - only in-building

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### Infrared PHY

- Frame Format
  - SFD, start frame delimiter
  - DR, data rate
  - DCLA, DC level adjustment



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## Infrared PHY

- Basic Access Rate is based on 1 Mbit/s 16-PPM modulation
- Enhanced Access Rate is based on 2 Mbit/s 4-PPM

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## Tutorial on 802.11 to 802

•the end

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