International Committee on
Global Navigation Satellite Systems

Case Studies:
Ultra Wide Band and Ligado

Disclaimer

The views and opinions expressed herein do not necessarily reflect the official policy or position of any government agency

What's Ultra WideBand (UWB)

Very narrow time domain pulses

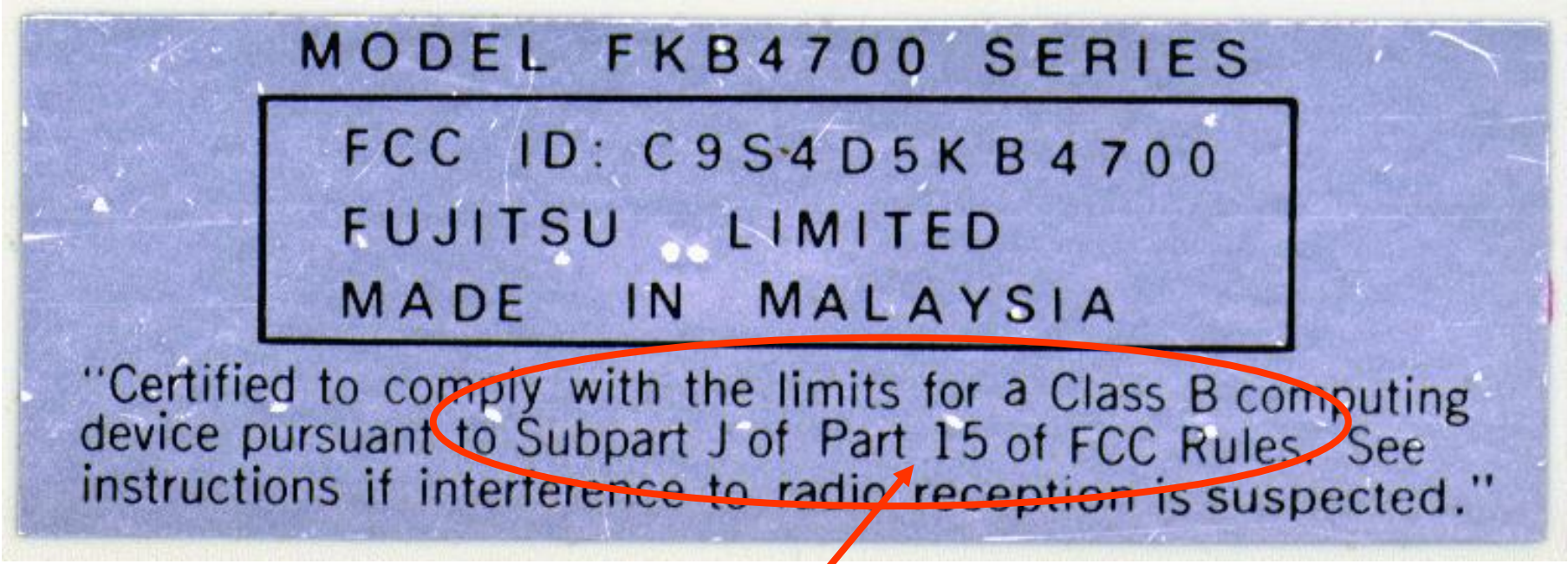
Create a very wide frequency spectrum

Sub-nanoseconds $\Rightarrow$ GigaHertz

UWB vs GPS – Conflict in Priorities

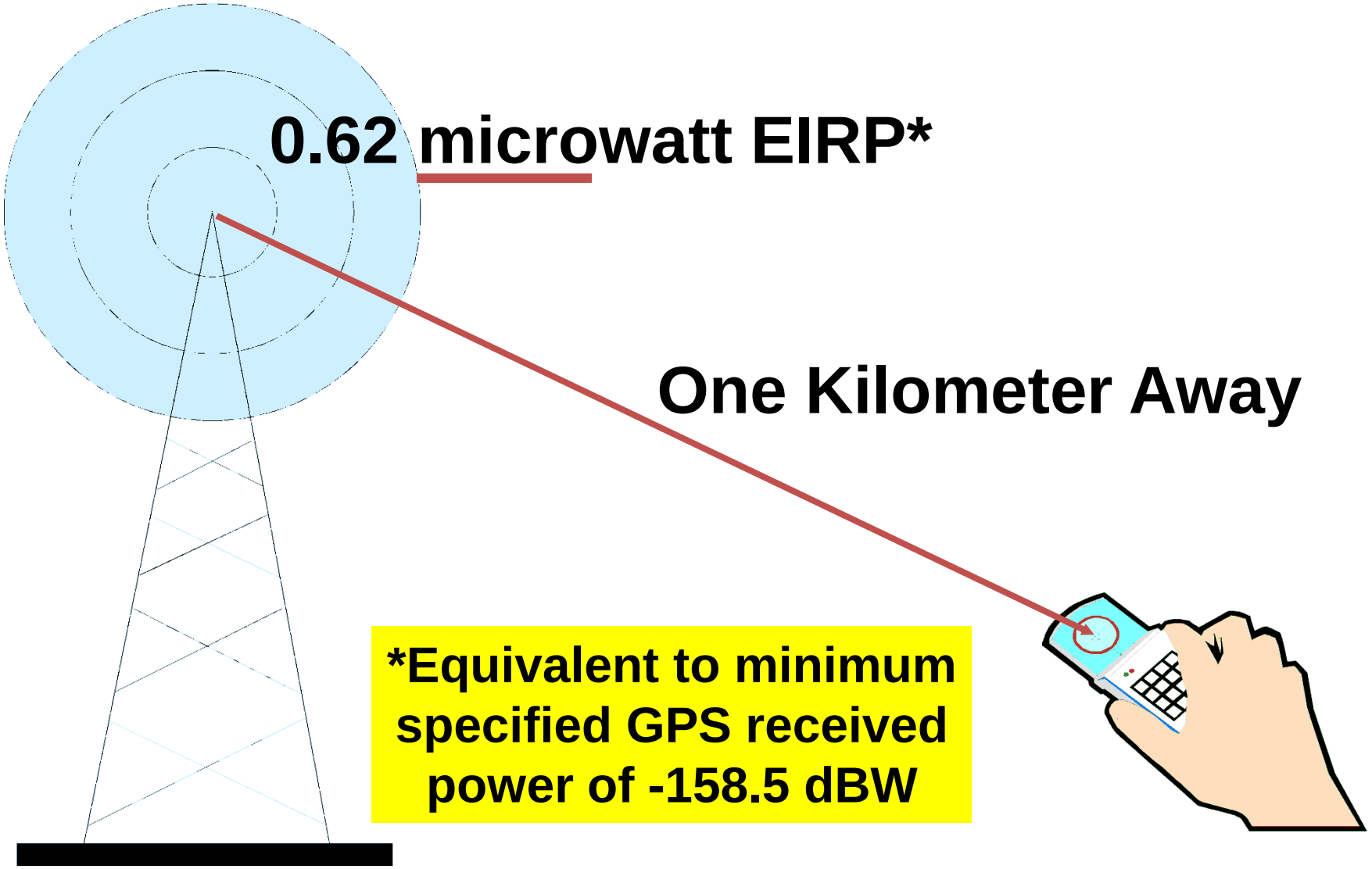
- The FCC and companies like Intel, Microsoft, and Sony saw UWB as an important step forward
  - Wideband, multipath-free communications
  - "Free" spectrum
    - UWB energy is lightly sprinkled across many frequency bands
    - With such low spectral power density, who could care?
- Omnidirectional users of satellite signals care
  - Because satellite signals are extremely weak

Part 15 of FCC Rules

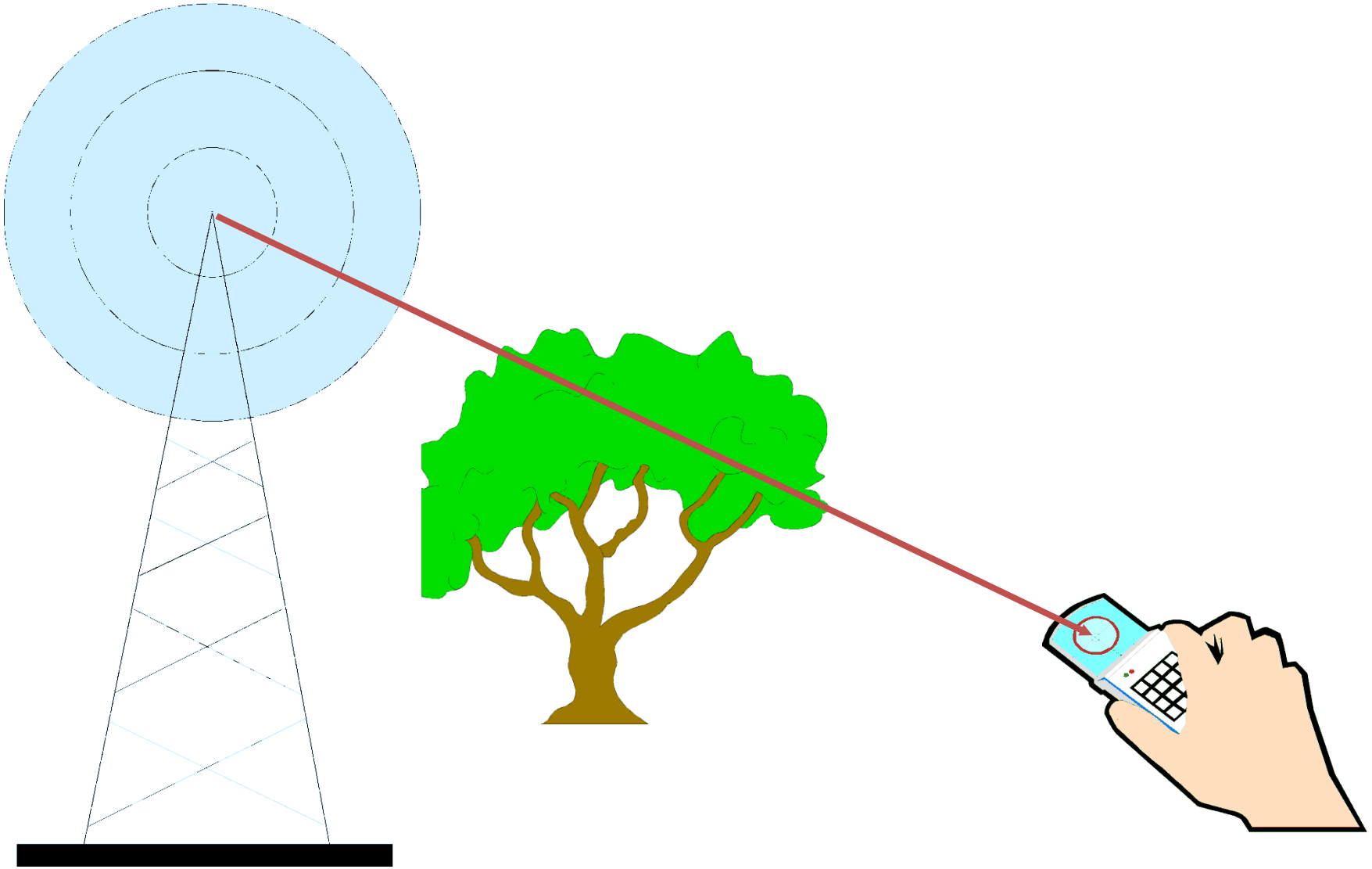


Unintentional radiation is limited by FCC Part 15 rules to –41.3 dBm/MHz EIRP

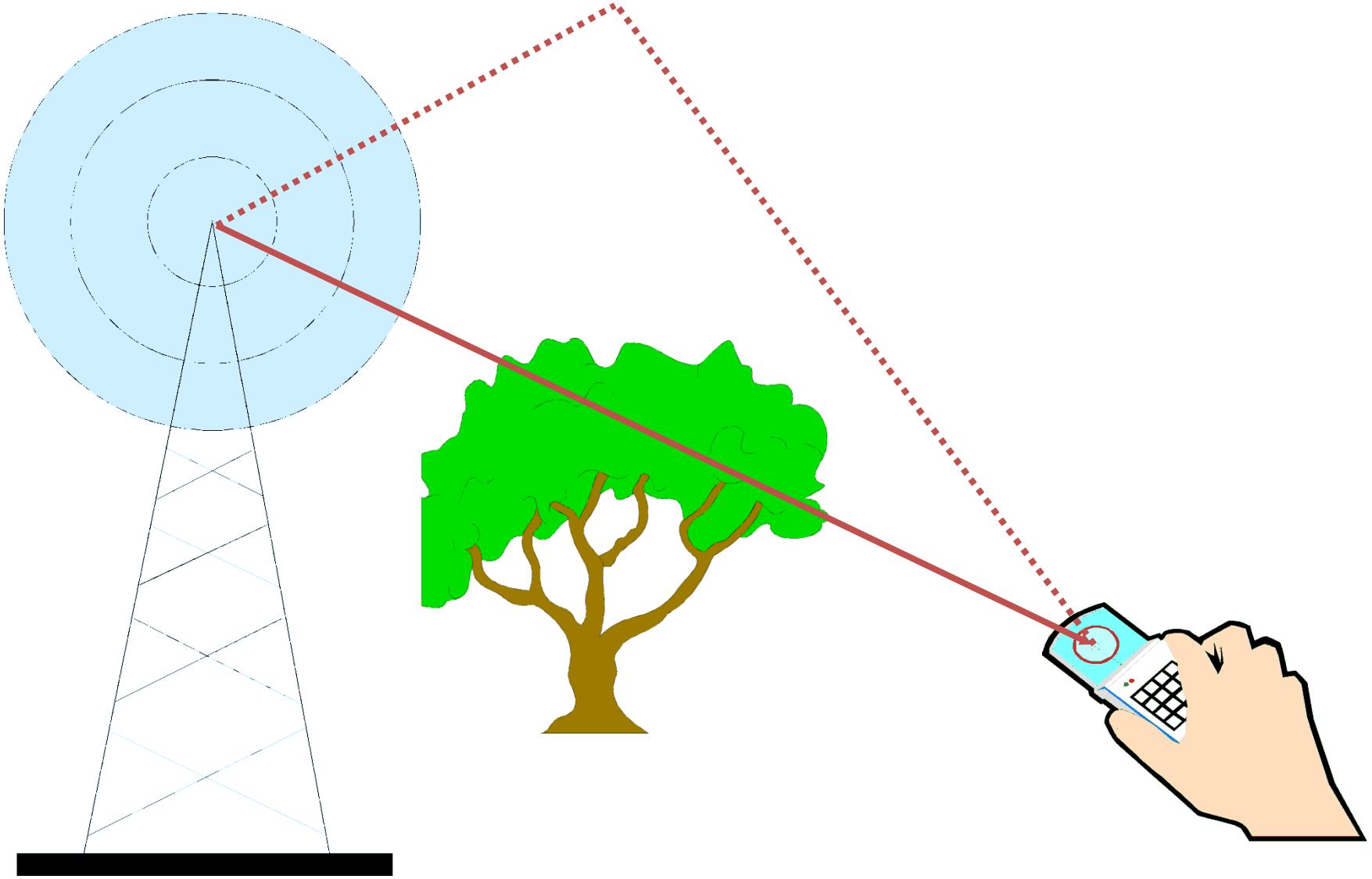
GPS Signals Start Out Very Weak



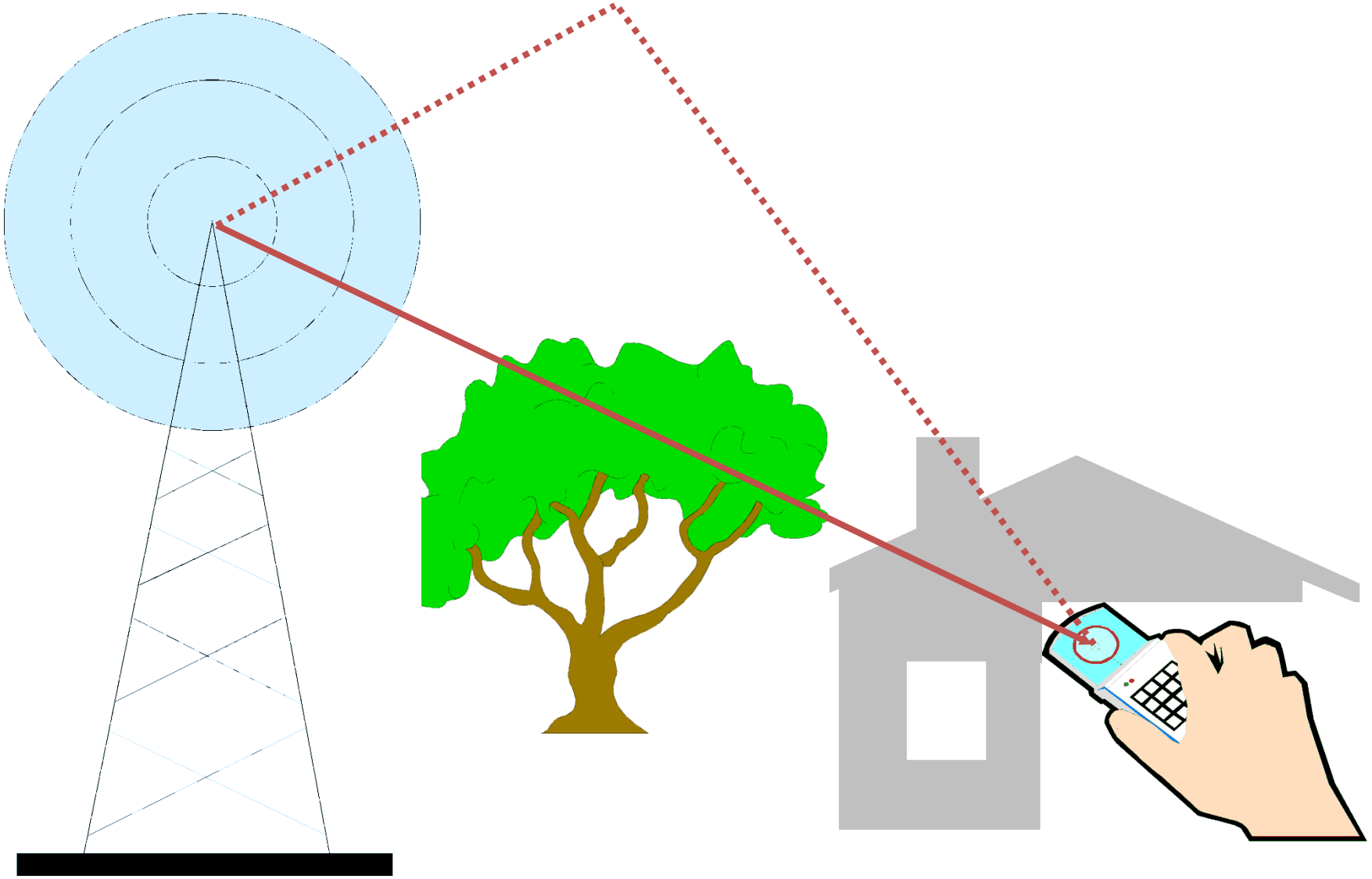
And can be Attenuated by Foliage



Further Attenuated by Multipath



Even More Attenuation Indoors



UWB Criteria Selected for GPS Protection

- It is **not** possible to regulate the user density of Unlicensed, Uncontrolled, Ubiquitous UWB emitters
  - One prediction: “1,000’s in homes, 1,000,000’s in an industry”
- It is only possible to regulate the emissions from **each** individual device
  - Backed by a vigorous testing and product recall program
- Therefore, in the GPS bands the UWB criteria is:
  - Allow <u>each</u> UWB emitter to raise the GPS noise floor
  - By 26% (1 dB) at a distance of 6 feet (1.83 m)
  - Which requires an EIRP at or below –75.3 dBm/MHz (–105.3 dBW/MHz)
- In comparison, the cost and the time required to raise the power of all 28-31 GPS satellites by 26% would be Billions of dollars and at least 15 years

Cover of December 2001 FCC Presentation

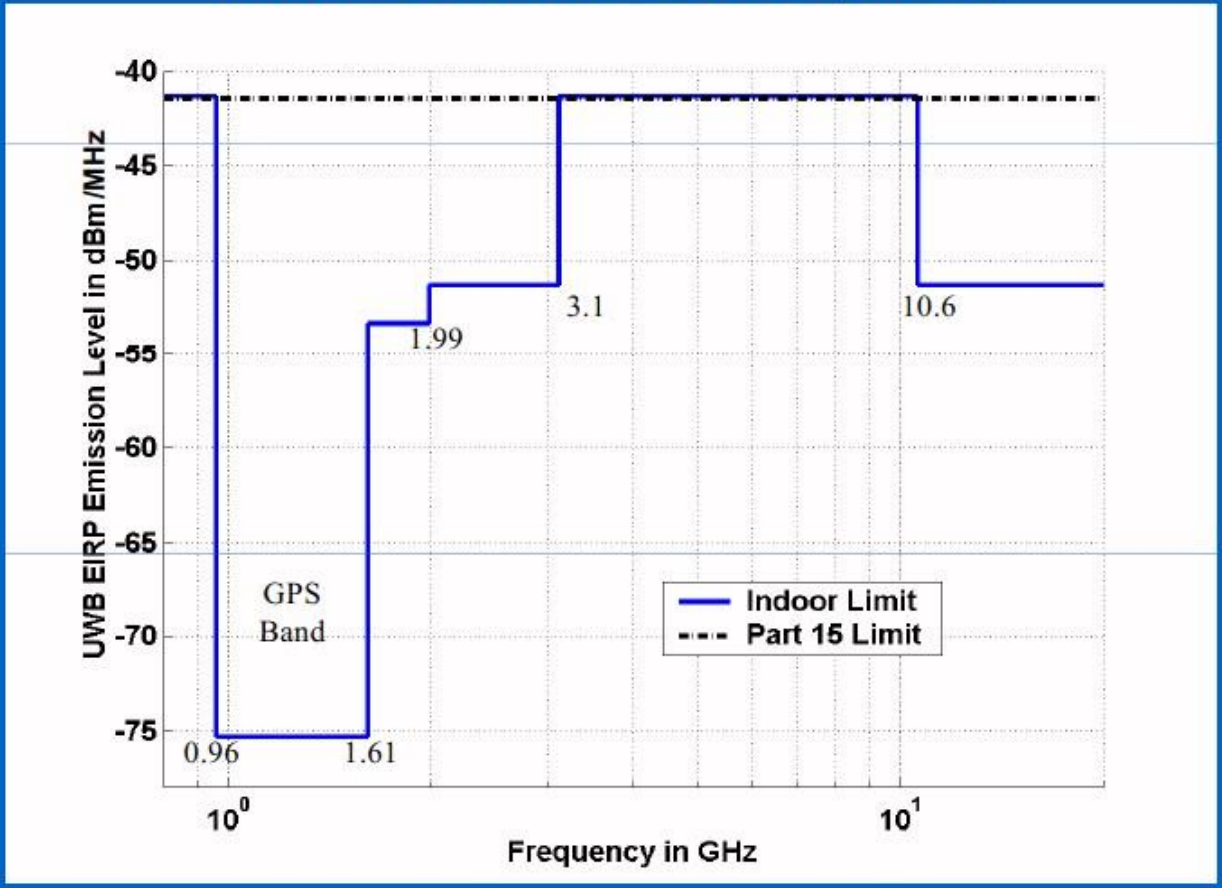
Walk DON'T Run - The First Step in Authorizing Ultra-Wideband Technology

Ron Chase
ITU-R Chair U.S Task Group 1/8 on UWB
Federal Communications Commission

-75.3 dBm/MHz, 34 dB Below Part 15 Limit

UWB Emission Limits

Indoor Communications Systems

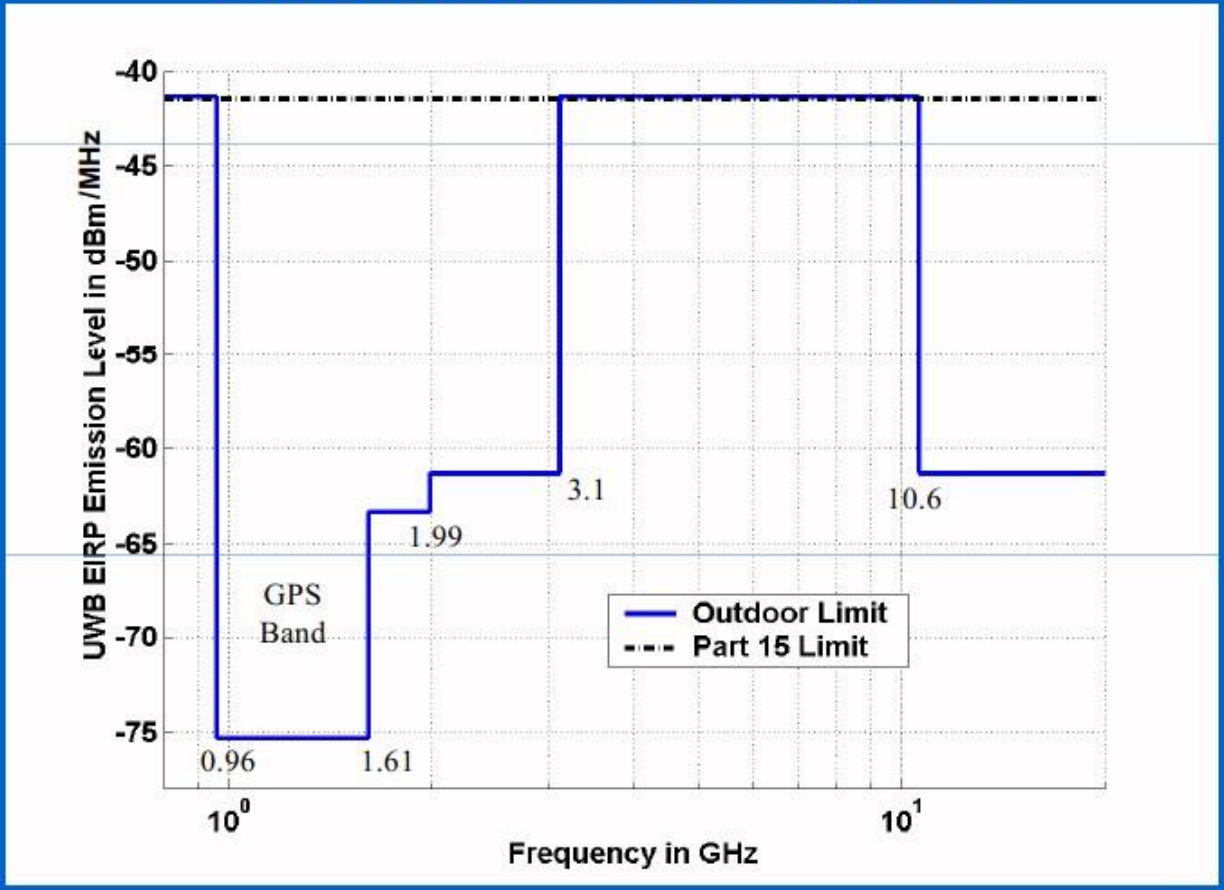


Equipment must be designed to ensure that operation can only occur indoors or it must consist of hand-held devices that may be employed for such activities as peer-to-peer operation.

-75.3 dBm/MHz, 34 dB Below Part 15 Limit

UWB Emission Limits

Outdoor Communication Systems

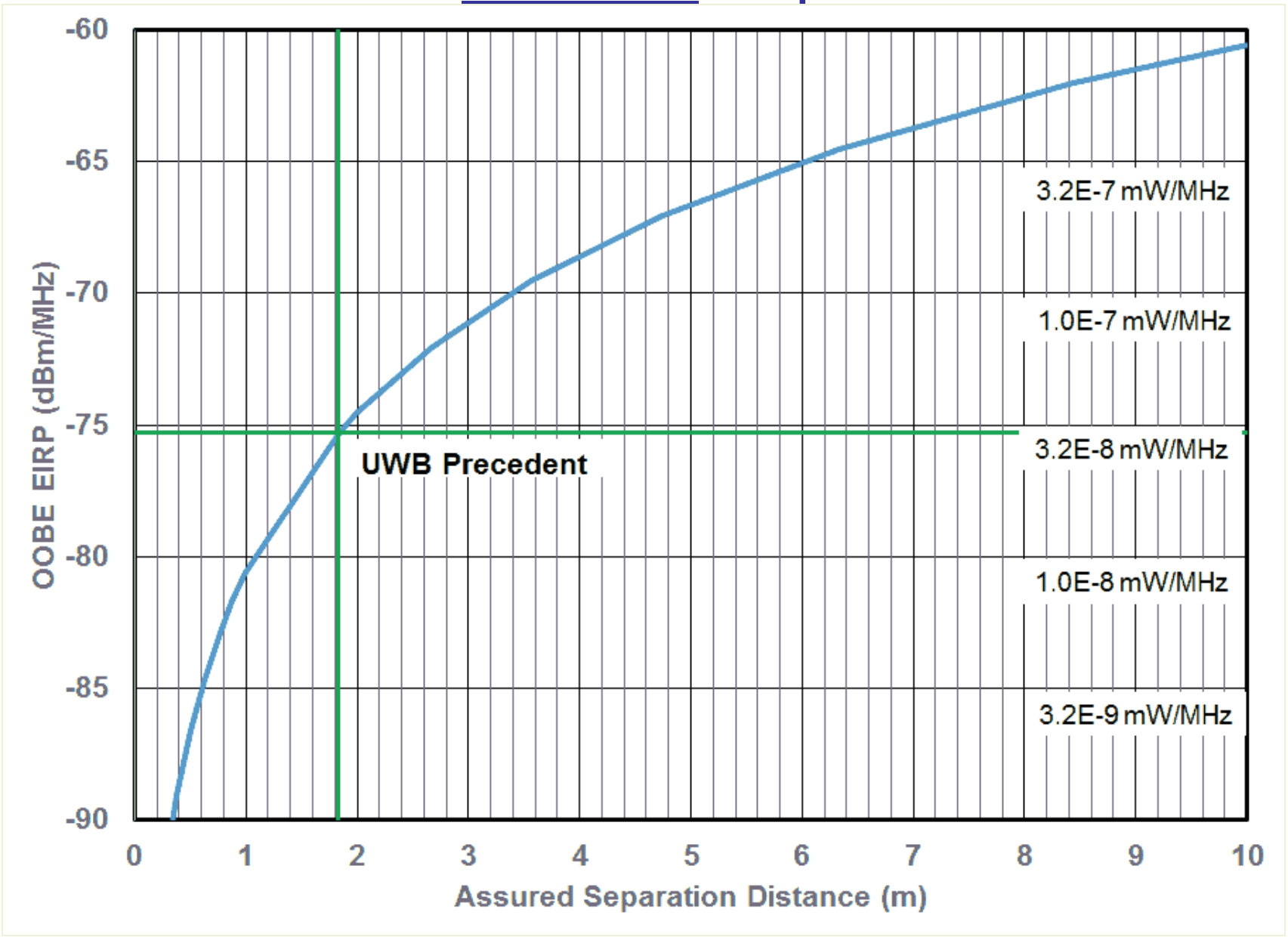


Equipment must be hand-held.

Using the UWB Agreement as a Model

- Based on the UWB Agreement, the following chart shows:
  - The Equivalent Isotropic Radiated Power (EIRP)
  - Of Out-Of-Band-Emissions (OOBE)
  - Received within the GPS L1 band
  - From a transmitter at an assured minimum distance from any GPS receiver
- This must be achieved by
  - Filtering at the transmitter
  - Transmitter power control if needed
- Assured distance means the GPS receiver and the transmitter must never be that close

OOBE EIRP vs. Assured Separation Distance



Unintentional Radiation Limit

- The FCC regulates unintentional radiation with Part 15 rules, requiring EIRP to be less than -41.3 dBm/MHz
- The UWB industry asked the FCC for permission to intentionally transmit that level of noise-like signal, including within the GPS spectrum
- Ultimately,the FCC UWB Report & Order (R&O) limited most UWB emissions to -75.3 dBm/MHz EIRP, 34 dB less than Part 15 power in GPS bands
- What reasonable limit should apply to unintentional radiation?
- What standard does your country use?

Adjacent Band Concern Example: Ligado

What is an adjacent band?

- Two frequency bands next to each other are called "**adjacent bands**"
- Radio Regulation services allocated in adjacent bands have characteristics that allow them to be **compatible**
- compatible adjacent band services are typically similar, eg ground to Earth satellite emissions
- services that are incompatible and therefore not suitable to be in adjacent bands are typically very different in nature
  - eg TV (very high power) and mobile phone (high power) networks

Being a 'good neighbour'

- Adjacent band compatibility means that the emissions of radio services in adjacent bands do not cause unacceptable interference to each other – they are good neighbours
- How do you know different services will be good neighbours?
- Ask the ITU!
- ITU Member State experts (working within ITU **Working Parties**) consider in detail how two different services would work as neighbours

Adjacent band compatibility studies

- ANY proposal to change the Radio Regulations to make a new allocation for a radio service is always studied carefully to assess the impacts on existing services
- the studies will consider the parameters for each service as well as how they are used, or would be used
  - eg, power levels, antenna types/direction, receiver sensitivity, frequency characteristics, indoor/outdoor, fixed position or mobile
  - these are built into a model to determine the degree to which the two services interfere with each other
  - depending on results, the proposed allocation may or may not be compatible with the existing service

When it can go wrong

- If new allocations/services are introduced:
  - without compatibility studies being carried out
  - or if incorrect parameters are used
  - or assumptions about existing usage are incorrect
    - ⇨ then **interference is a real risk!**
- this could happen if a country decides to introduce new services without proper studies
- this is especially risky for GNSS, with such low level signals:
  - spectrum occupancy measurements are unlikely to show the presence of GNSS signals
  - if other radio services then use nearby frequencies
    - ⇨ **interference to GNSS is a real risk!**