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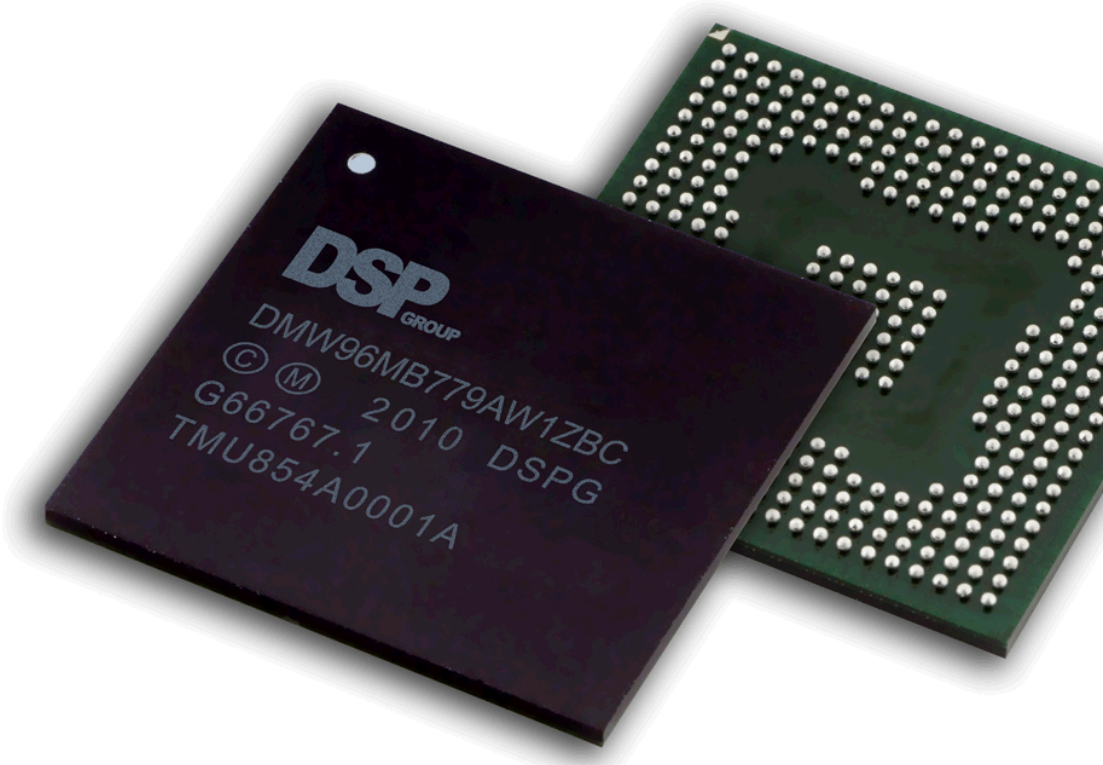


DECT and ULE: Overview of PHY and Lower MAC Protocol

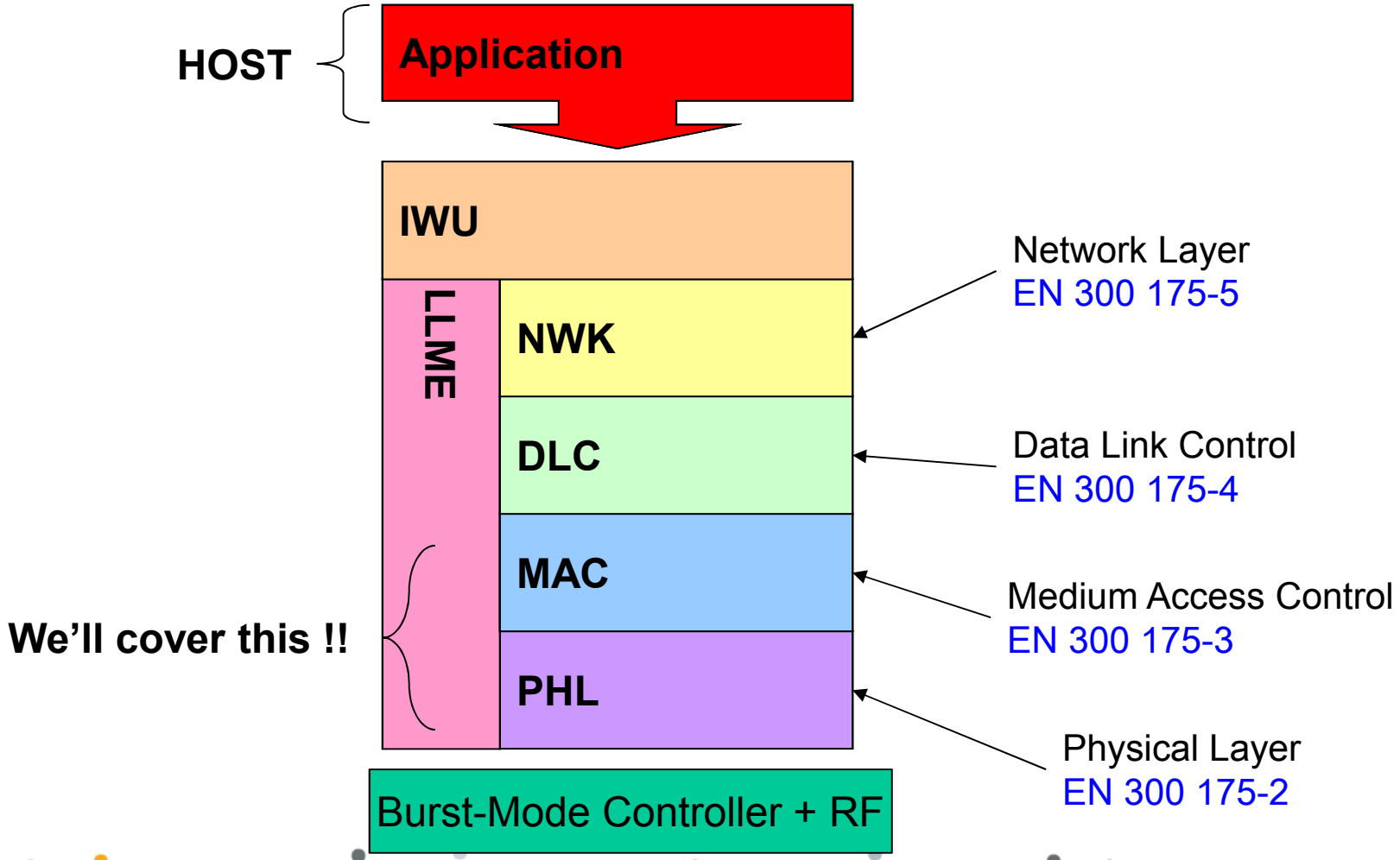
LS

Feb‘14

Digital **E**nhanced **C**ordless **T**elecommunications

Presentation Objective: Familiarize “newcomers” with the physical and medium access layers of the DECT and ULE Protocols

Scope of Training



Key Features of the PHY/MAC

- DECT over-the-air raw bit rate is 1.152Mbs
- DECT utilizes 5-10 RF Channels (region dependent)
  - EU has 10: 1880-1898M (ETSI 300-175)
  - US (DECT6.0) has 5: 1921-1929M (FCC Part 15.323)
  - Japan has 5:1897-1905M (ARIB_STD-T101)
- Channel Spacing is 1.728MHz
- Time Domain Multiple Access (TDMA) – 6 (in advanced systems 12) available slot pairs in a 10mS Frame
- Time Division Duplexing (TDD) – 5 mS of Tx Slots (packets), 5mS of Rx Slots
- Network Configuration is a star – stars can be overlapped and synchronized to create cellular coverage

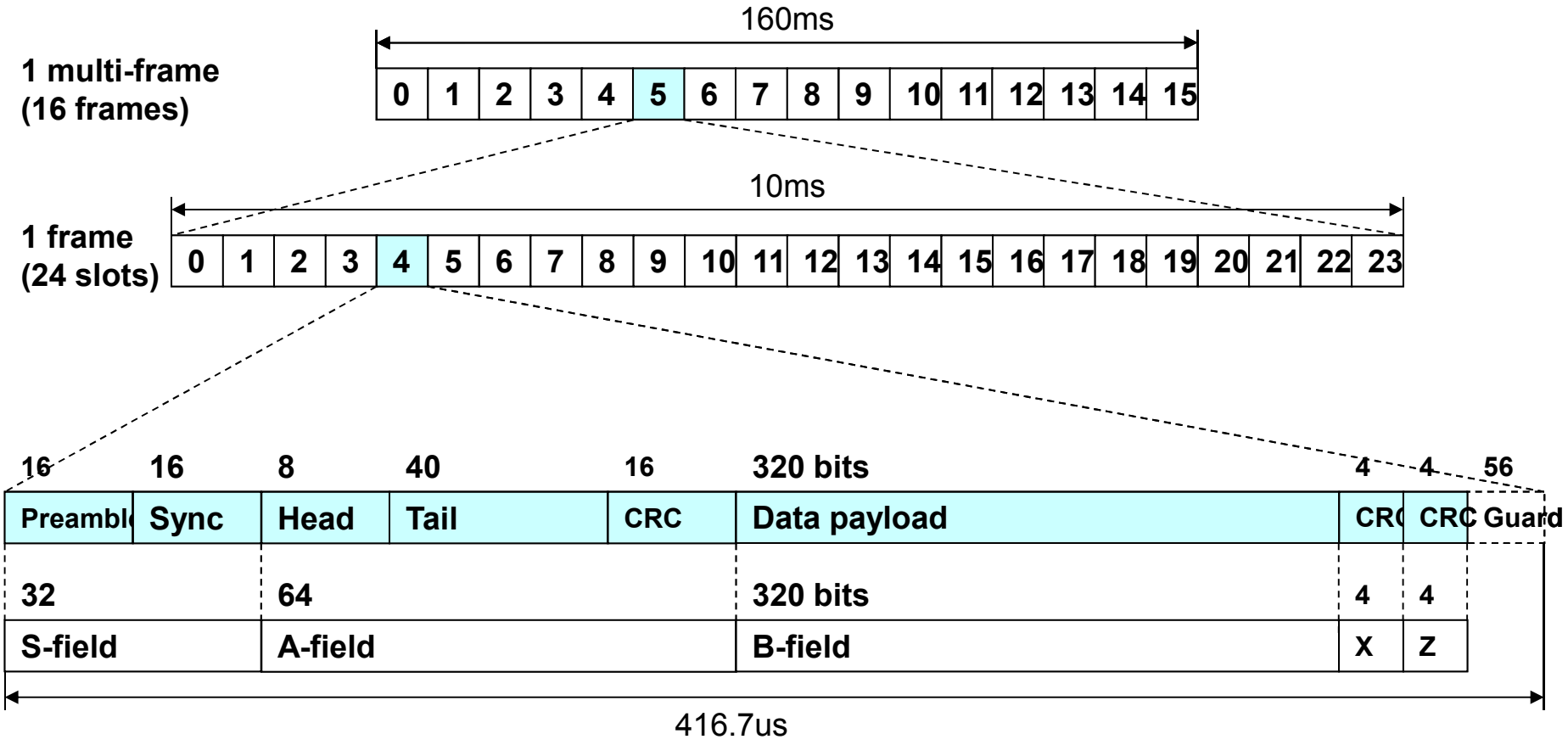
DECT & Regulatory Bodies

- ETSI 300-175 (DECT was “born” in the EU!)
  - Defines and standardizes the protocol to lay the groundwork for compatibility between vendors
  - Protocol stack includes over-the-air Test Mode
  - Specifies physical layer performance criterion and verified protocol compliance
  - Calls out channel access etiquette
  - Constrains use of spectrum (Tx Mask, PSD, out-of-band spurs)
- FCC & ARIB (DECT migrated to US and Japan!)
  - No interest in compatibility or performance
  - Expands channel access etiquette and rigidly enforces
  - Constrains use of spectrum
- Other regions – Typically adopt FCC or ETSI policies

DECT - ULE Players: The FP and PP

- **FP** is the Fixed Part: Also called Base Station (BS) in the Cordless domain, Controller/Concentrator in ULE. It is at the center of the star network and includes some kind of connection to the WAN (PSTN, IP, Cellular)
- **PP** is the Portable Part: Also called Handset (HS) in Cordless, Device/Sensor in the ULE domain

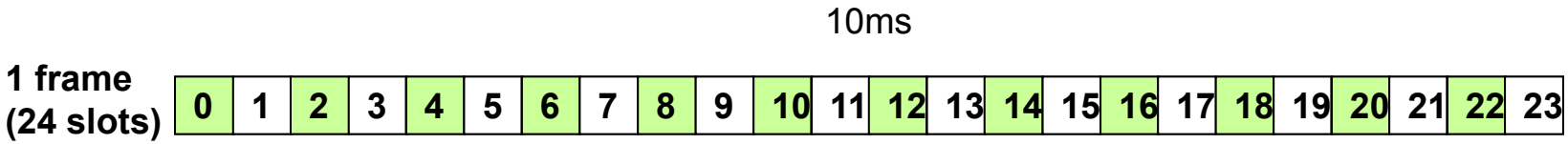
Slots and Frames



The DECT frame is split into 2 equal halves

- Slots 0-11are the down-link, i.e. FP to PP transmission
- Slots 12-23 are the up-link, i.e. PP to FP transmission

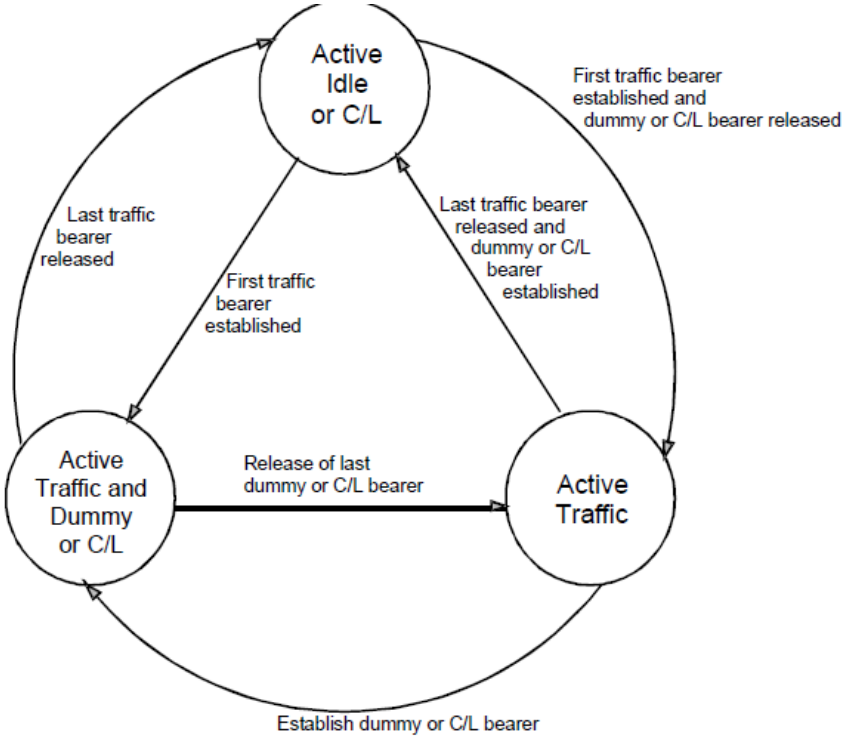
Blind Slots, Non-Blind Slots



*In most systems, every other slot is “blind” - earmarked for tuning the RF synthesizer and other “housekeeping”. This implies that only 6 Tx-Rx slot-pairs are available for connectivity

*In advanced systems with fast-hopping synthesizers (and better housekeepers!), all 12 slot-pairs are available. This is also called a non-blind slot (NBS) system

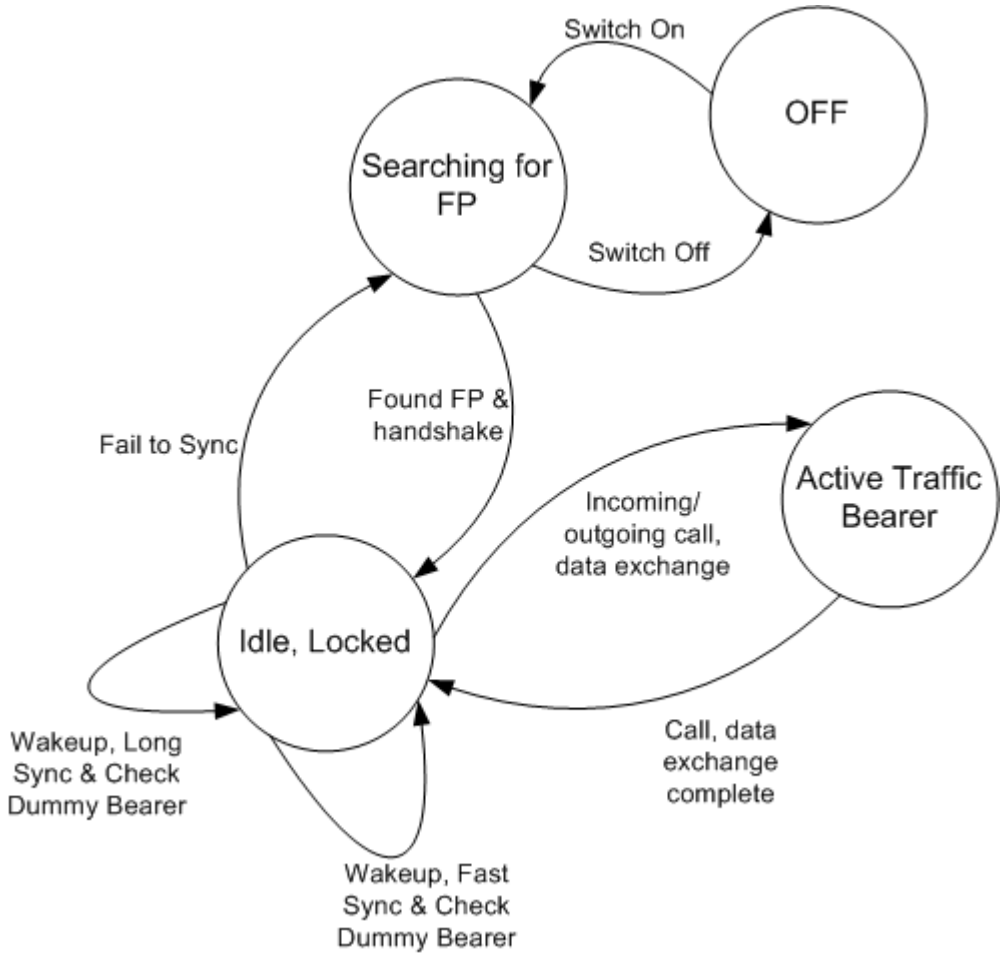
FP State Machine



*__Active Idle__: Transmitting ~100µS beacon (=dummy bearer) once every 10mS. Also activating all (6 or 12) Rx slots awaiting requests from a PP. A “Cordless FP” will occasionally RSSI scan inactive Tx slots for “conflicting” DECT activity. An FP serving ULE devices will employ more intensive background scanning, both to relieve the ULE device from scanning as well as to detect attempts at sabotage of security system via jamming

*__Active Traffic__: Up to 6 (or 12) PPs have established a link (traffic bearer) with the FP. Each PP is allocated at least one Tx and Rx slot in every 10mS frame

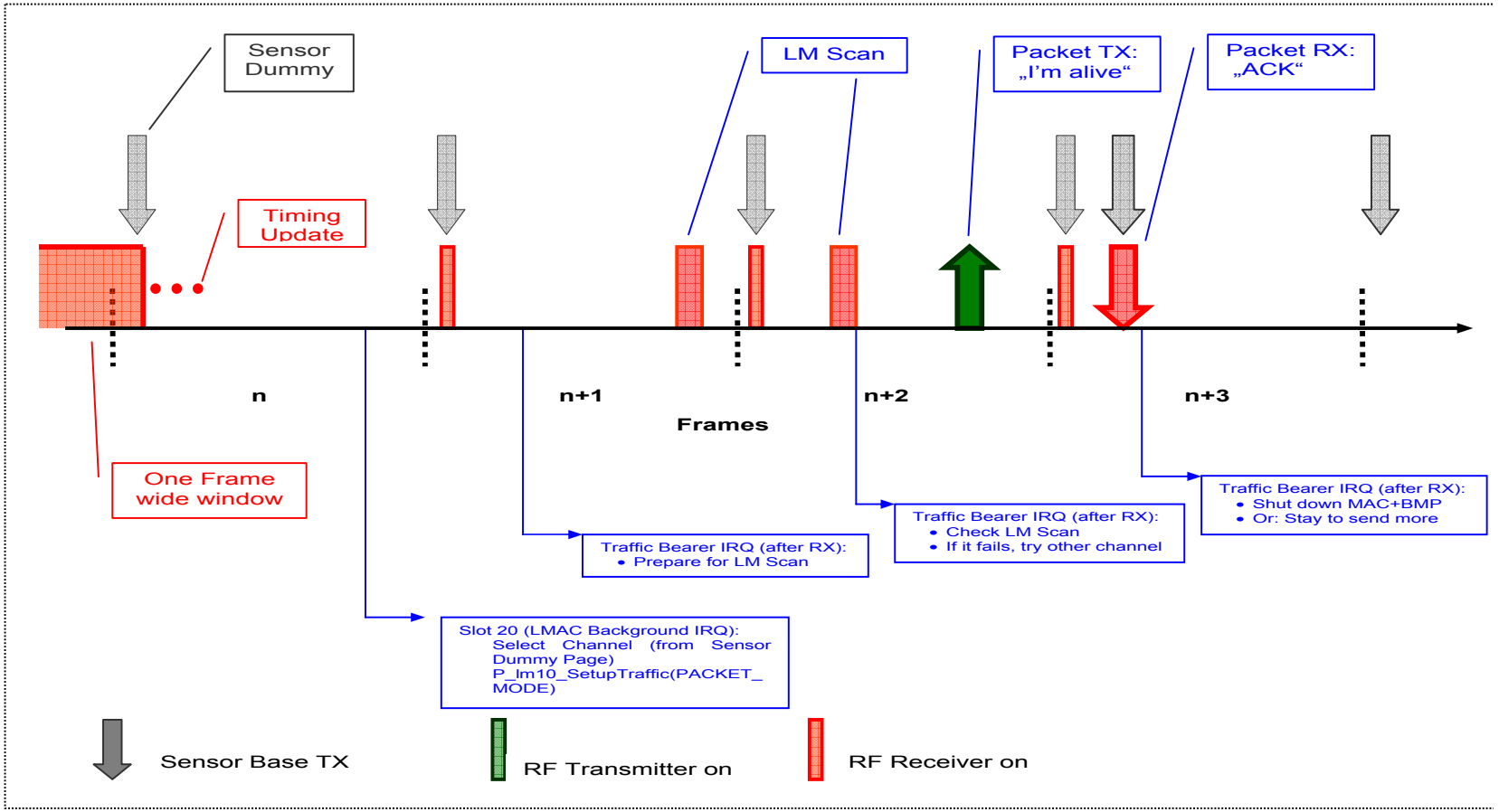
PP State Machine



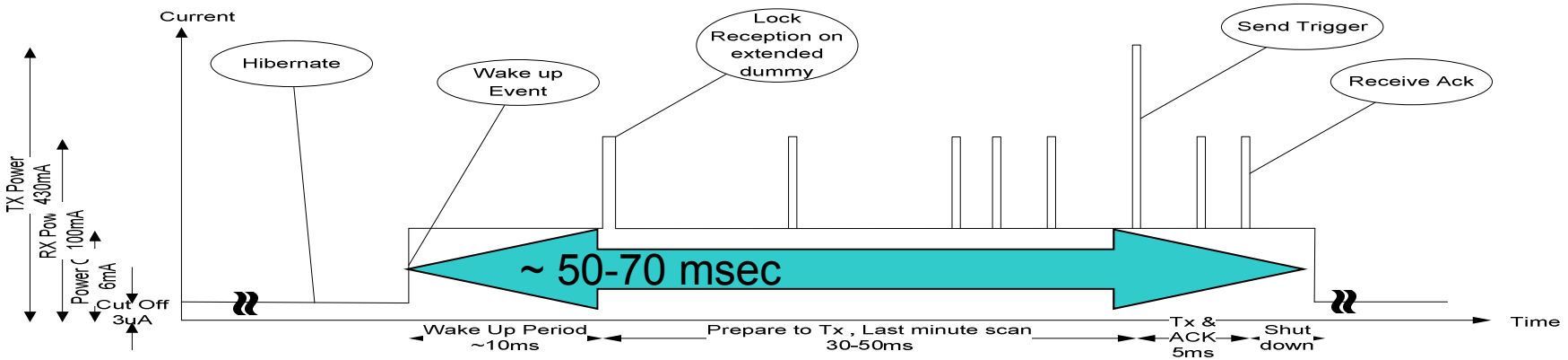
*__Searching for FP__: Continuously in Rx Mode, scanning RF Channels, looking for its FP. May take several 100mS.
*__Idle Locked__: PP is powered down. In ULE this is called hibernate. System wakes up and reSyncs to FP Beacon. Frequency of wakeup in Cordless is once every 640mS. In ULE it varies with the application
*__Active Locked__: PP has established a traffic bearer (=link) with the FP. In Cordless, this slot-pair is used each frame and maintained indefinitely (effectively circuit-mode). In ULE, a traffic bearer is maintained for a short sequence of frames and then terminated (effectively packet-mode)

Fast Sync: Receiver wakes up and reSyncs to FP beacon with a few µS. This is the case in all Cordless Apps (wakeup every 640mS) and in many ULE apps (wakeup < few minutes)
Long Sync: PP clock has drifted “far” from FP. ReSync to FP may take as long as 10mS….

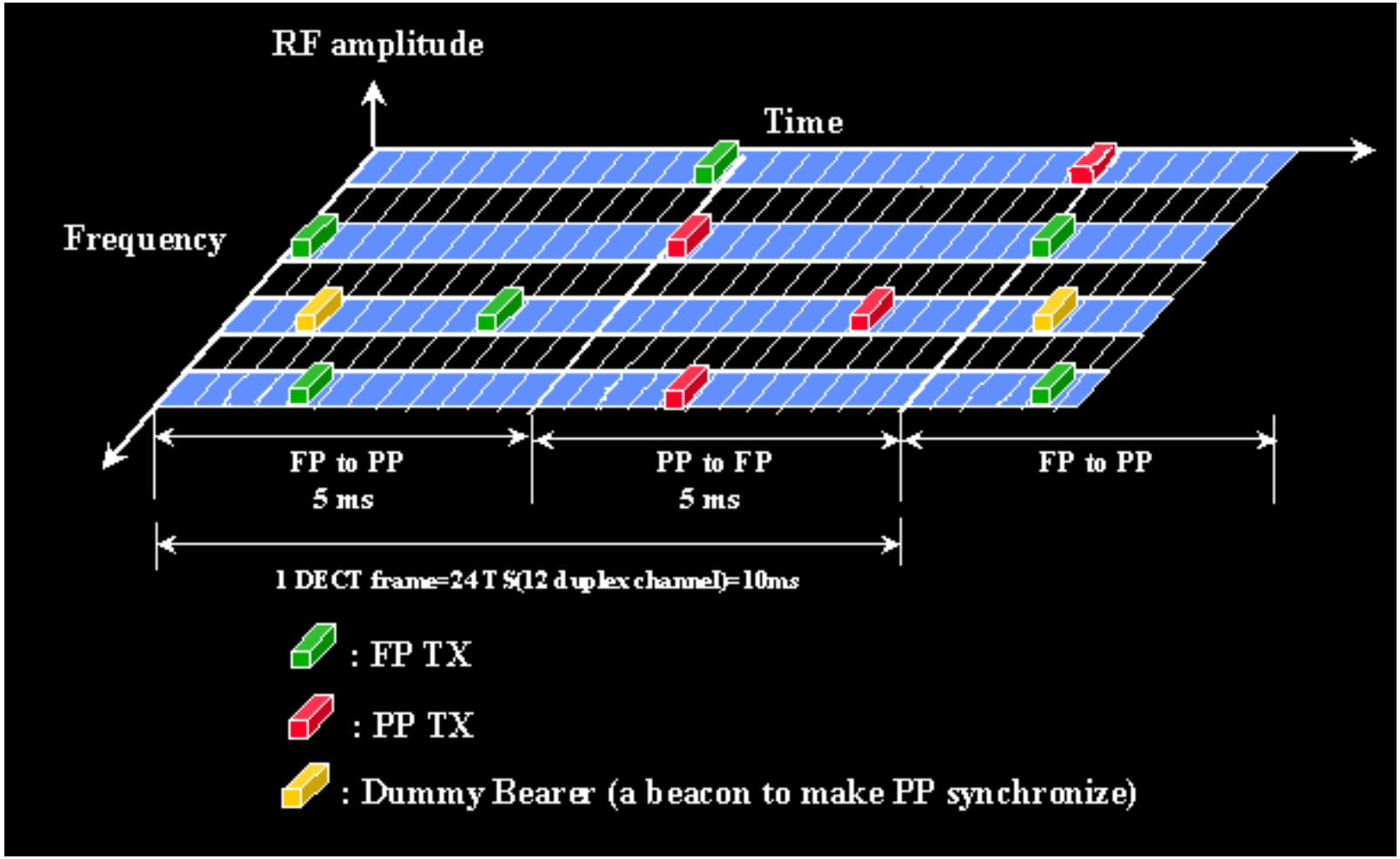
PP ReAcquire of Sync, setup of Traffic Bearer



DECT ULE Wakeup Sequence – DHX91



Traffic and Dummy Bearers



Putting it all together!!

Dynamic Channel Allocation: Etiquette

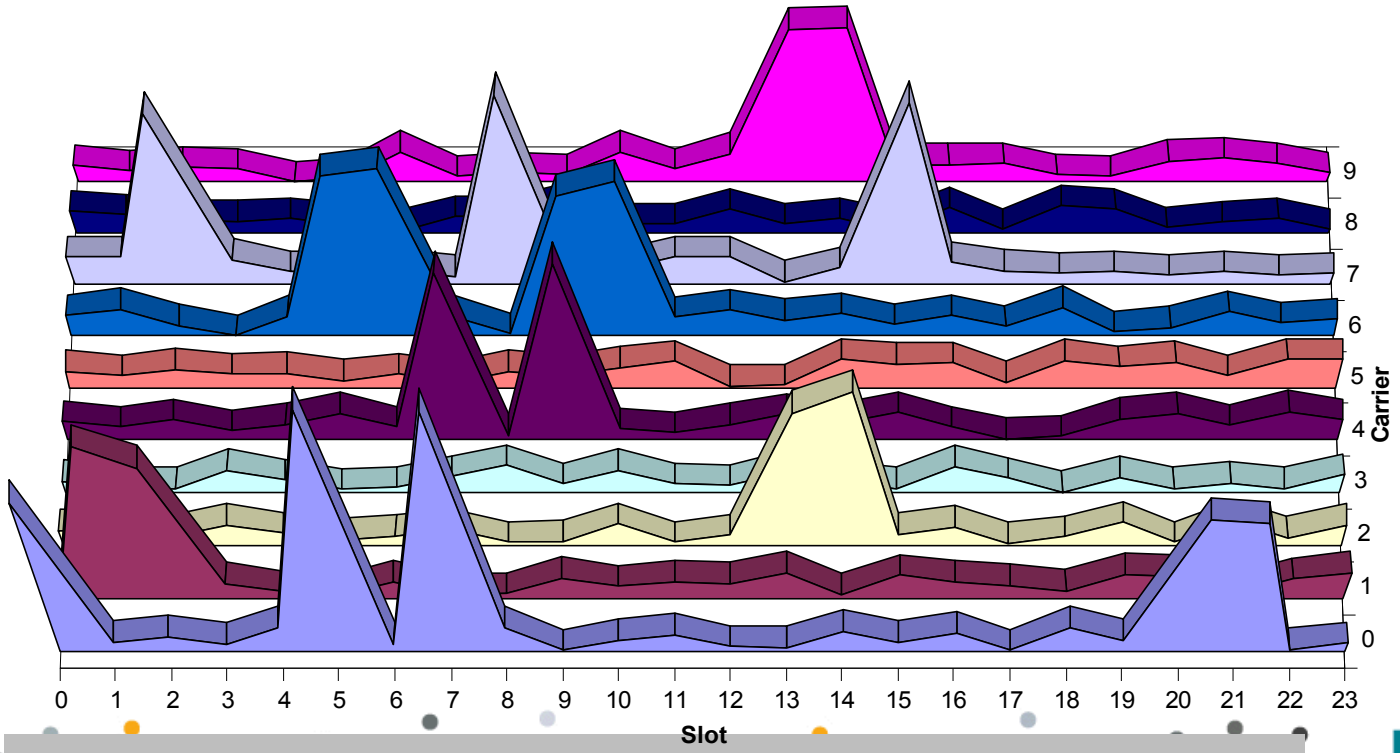
- A PP or FP can use any timeslot on any RF carrier
  - No cell planning required
- Before transmission, must make RSSI measurement on proposed slot pair
  - Both the FP and PP maintain tabulations (via “background scanning”) indicating preferred clean channels/slots for communication
  - The FP is responsible to “clear” the channel prior to initiating or adjusting its beacon transmission
  - The PP is responsible to clear the channel prior to initiating a traffic bearer transmission (note: the PP is ALWAYs the initiator of a traffic bearer)
- Collision recovery by handset
  - Initiates handover to different slot
  - Could be to a different carrier
  - Could be to a different base station

Background Scan: Tabulation of Signal Strength

Note: The “congestion” depicted in the diagram below would typify a scan in a densely populated apartment complex where DECT systems have been installed in 6+ of the neighboring units. In a single-family residential area, the result would be almost “clean”. This leaves plenty of opportunity to:

*support traffic bearer setup for cordless or ULE activity

*distinguish between competing DECT systems and attempts at sabotage via jamming



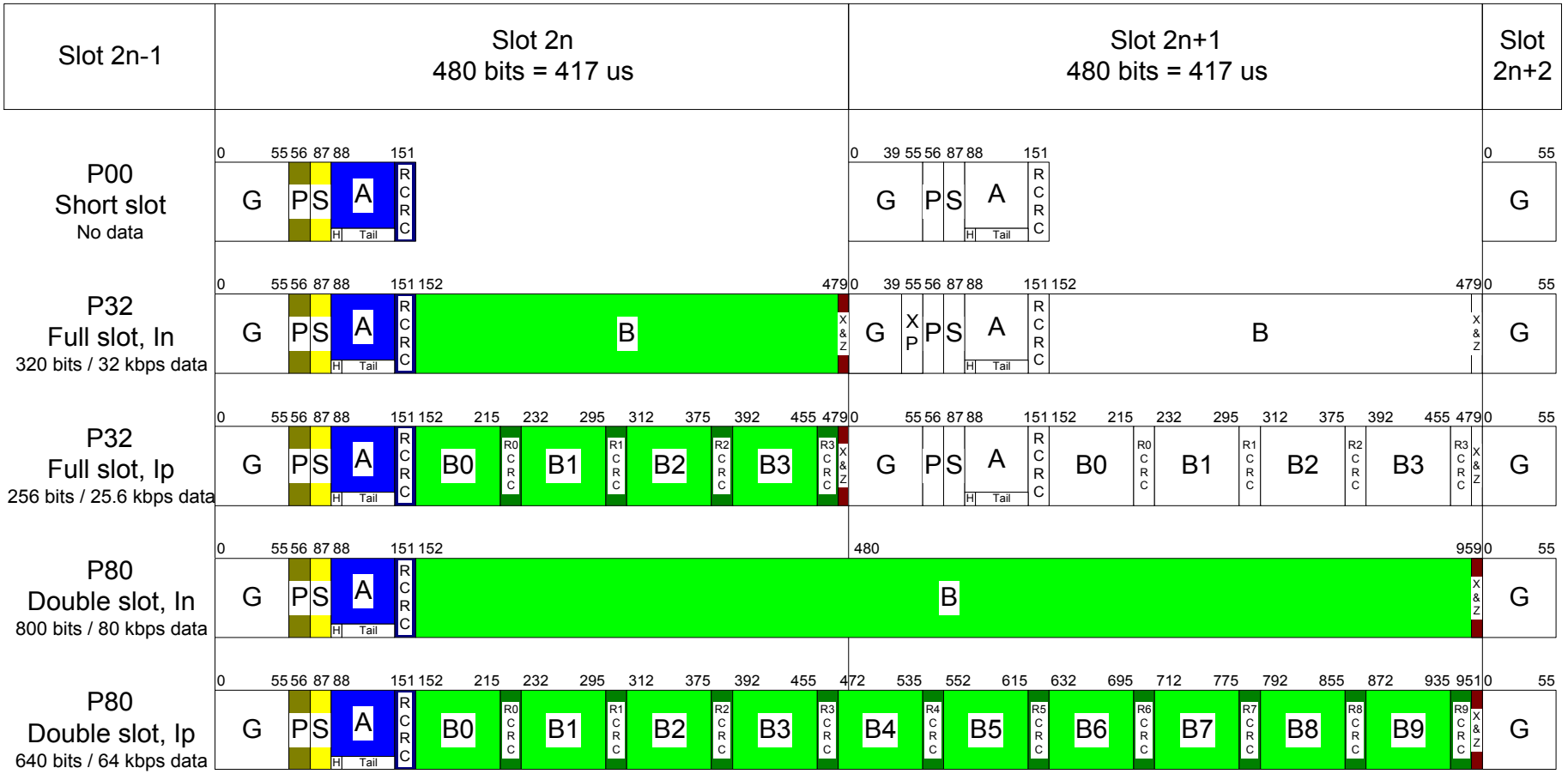
Signal Strength Readings at FP or PP side

Effective Data Rates: DECT & ULE

Notes:

a) ULE (packet-mode) systems currently support one P32 (with CRC protection) per frame per device

b) DECT systems can aggregate multiple slots per frame for higher throughput



System Capacity

- The number of supported nodes for a DECT ULE System using 1 slot frequency pair (all other slots can be used for regular DECT operation) - can be derived from
  - the Bandwidth utilization (shown on the graph) and
  - The maximum delay
- The following capacity can be supported
  - 32Byte > 1000 nodes
  - 160Byte: ~ 400 nodes
  - 480Byte: ~200 nodes
  - 960Byte: ~100 nodes
- Note:

1. Use case for this simulation:
   - Each node is sending the payload once every minute and is receiving the same payload
2. In a real system payloads can be mixed as needed