EPoC Framing

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Changes From Previous Version

- Superframe numerical examples
  - Corrected slide 12-14 with SF size of 146 and ~ 320 symbols to a SF size of 254-256 symbols
  - Added an example with fine ranging
- Removed reference to guardbands in the figures
- Clarify how "no transmission allowed" in excluded subcarriers definition

Some definitions and Conventions

- Upstream subcarrier (SC) Types

  Allocated SC: a SC which is assigned to a RB to be used for US data transmission (either MAC data or PHY Link)

  Unallocated SC: a SC which is used for Probe symbols but is not allocated to any RB

  Excluded SC: a SC in which no transmissions is allowed (input to iFFT is zero)

  - Active SC
    – A SC that is not excluded (either Allocated or Unallocated)

- Resource Element (RE)
  – One allocated Sub-carrier in one symbol

- Resource Block (RB)
  – Contiguous spectrum of 1, 4, or 8 SC's
    - Not including Unallocated SC's
    - Not including Excluded SC's
  – Duration of an RB
    - 8, 12 or 16 symbols

Parameter conventions
"D" (for Duration) measured in us (ms if appropriate)
"S" (for Spectrum) measured in kHz (MHz if appropriate)
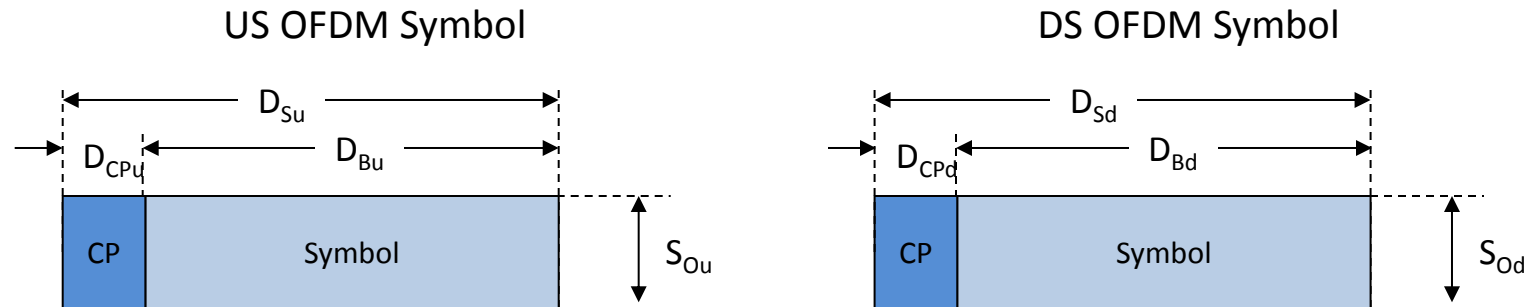Subscripting convention
Uppercase subscript(s) – describe object
        (S = Symbol, CP = Cyclic Prefix, B = useful Symbol, O = OFDM, PL = PHY Link, PLW = PHY Link Window, RB = Resource Block, SF = Superframe)
Lowercase subscript – direction (u = upstream, d = downstream)

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EPoC OFDM Symbols

US OFDM Symbol

DS OFDM Symbol

- **OFDM Symbol parameters**
  - Symbol duration (D_{Su}, D_{Sd})composed of
    - Useful Symbol duration (D_{Bu}, D_{Bd}); fixed at 20 us
    - Cyclic Prefix duration (D_{CPu}, D_{CPd}); configurable (Ref Cl 45.2.1.108/110)
      - US {1.25, 1.875, 2.5, 3.125, 3.75 us}
      - DS {1.25, 2.5, 3.75 us}
  - OFDM Channel Spectrum (S_{Od}, S_{Ou});
    - The range of frequencies from the lowest active subcarrier to the highest active subcarrier
    - Measured between center frequencies of the subcarriers
- **OFDM symbol parameters are set at network provisioning (requires network restart to change)**

EPoC Downstream Frame
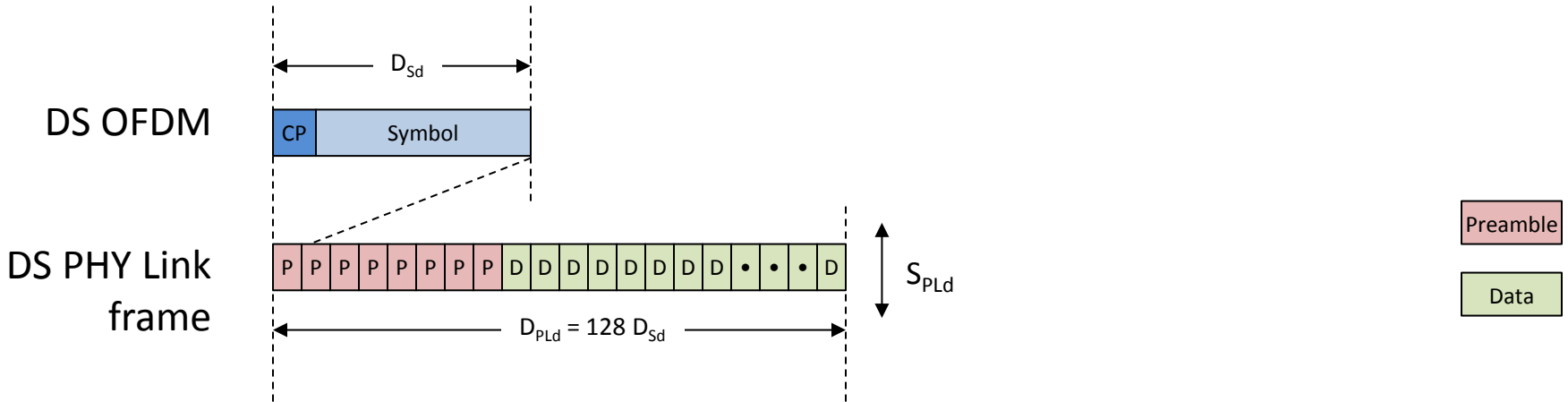
- Downstream framing composed of two items
  - Downstream Symbol Time (D_{Sd}) composed of
    - Useful symbol time (D_{Bd}); fixed at 20 us
    - Downstream CP time (D_{CPd}); variable {1.25, 2.5, 3.75 us}, set at network initialization (Ref Cl 45.2.1.108)
  - Downstream PHY Link Frame (D_{PLd})
    - Fixed at 128 * D_{Sd}
    - 2.72 us ≤ D_{PLd} ≤ 3.04 us (given D_{Bd} and range of D_{CPd})
    - PHY Link channel uses eight subcarriers

Upstream Framing: EPoC Resource Block
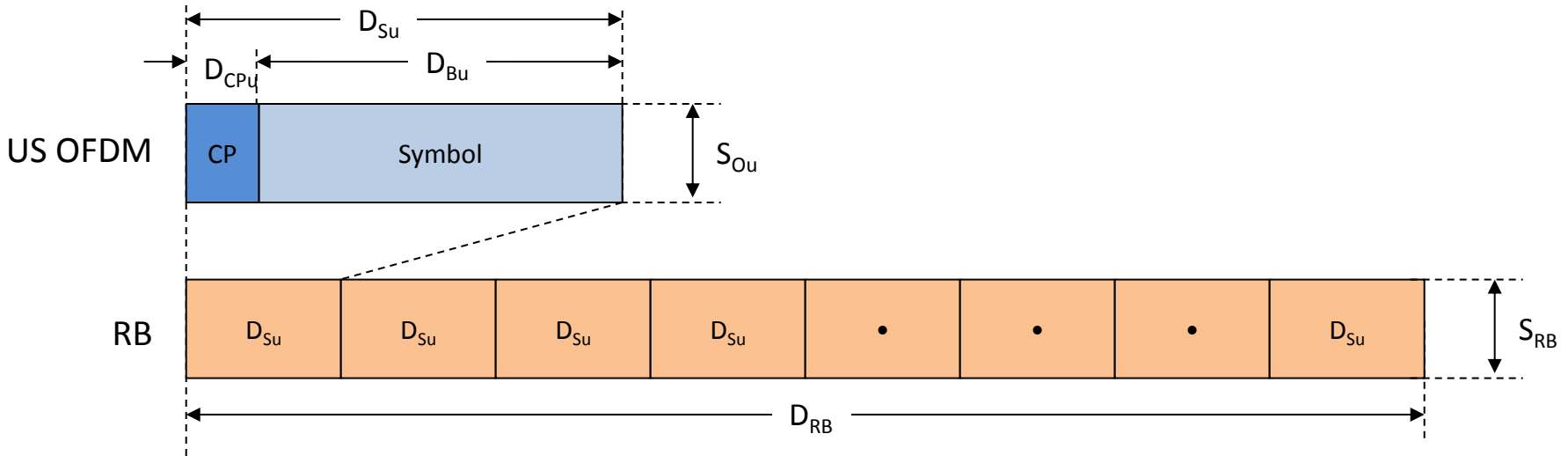
- Upstream OFDM frame parameters
  - RB duration (D_{RB}); configurable: 8, 12, 16 symbol durations (D_{Su})}
  - RB spectrum (S_{RB}); configurable: {1, 4, or 8} contiguous Allocated SC's
    - Proposed registers in 4/16 call
  - RB Volume; $V_{RB} = D_{RB} * S_{RB}$
- Resource Block Constraints
  - All RB's have same number of symbols and the same number of subcarriers
- Resource Block parameters are set at network initialization

Upstream Framing: Probes
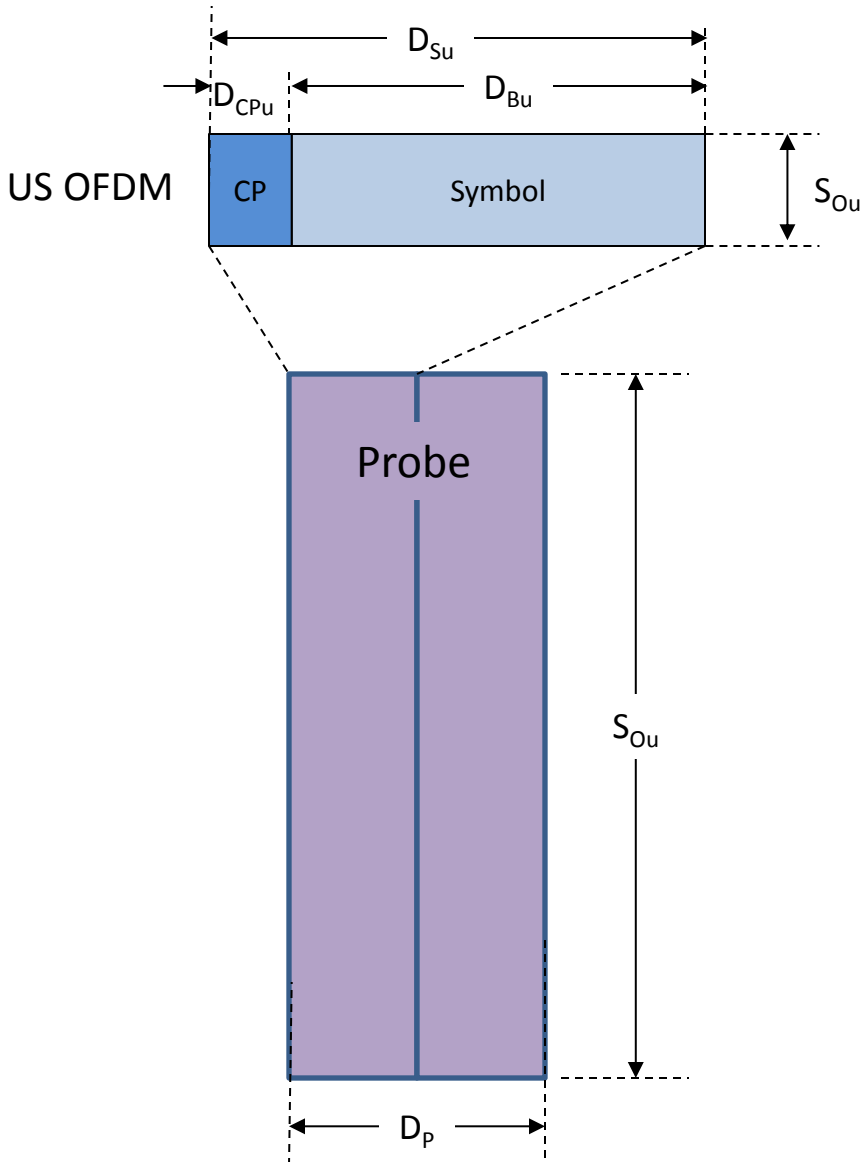
- Parameters
  - Probe duration;
    $D_P = N_P * D_{su}$
  - Probe Spectrum; same as symbol (S_{Ou})

- Probes Constraints

    $2 \leq N_P \leq 4$

- Set at network initialization

Upstream Superframe

A Column of Resource Blocks can be referred to as an OFDMA Frame
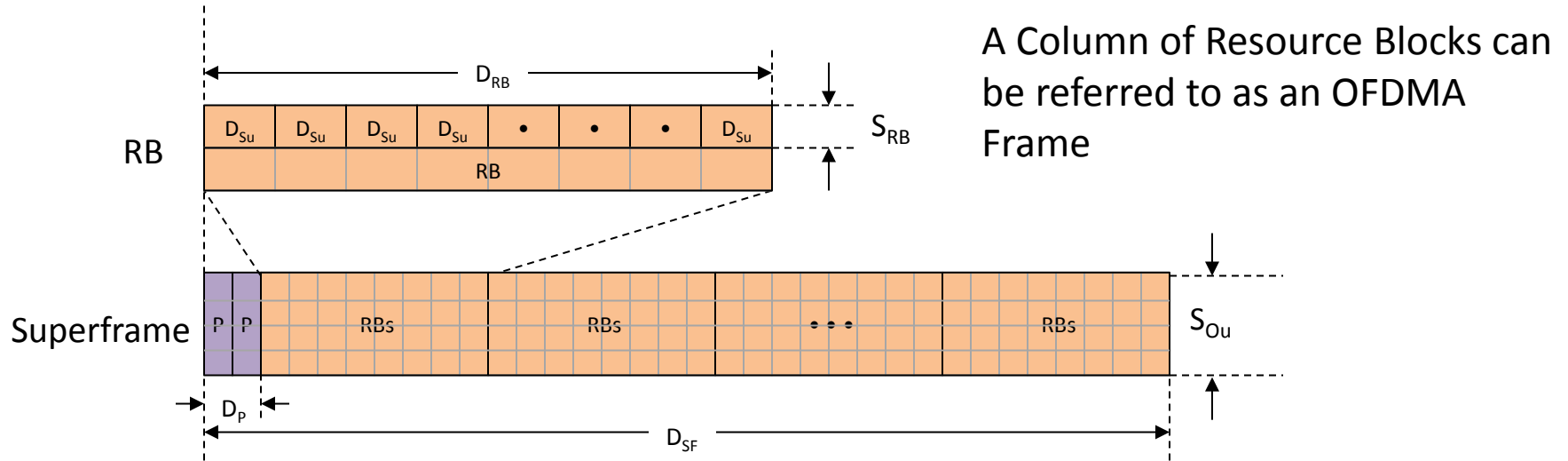
- Upstream Superframe comprises of Probe symbols followed by an integer number (N_{SF}) of RB columns
- Upstream Superframe Parameters
  - SF Duration; $D_{SF} = D_P + N_{SF} * D_{RB}$
    - Duration is the Probes plus an integer number of US Resource Blocks
  - Spectrum; S_{Ou} – set via US Profile descriptor (Ref Cl 45.2.7a.2)
- Superframe parameters are set at network initialization

OFDMA Frame Numbering
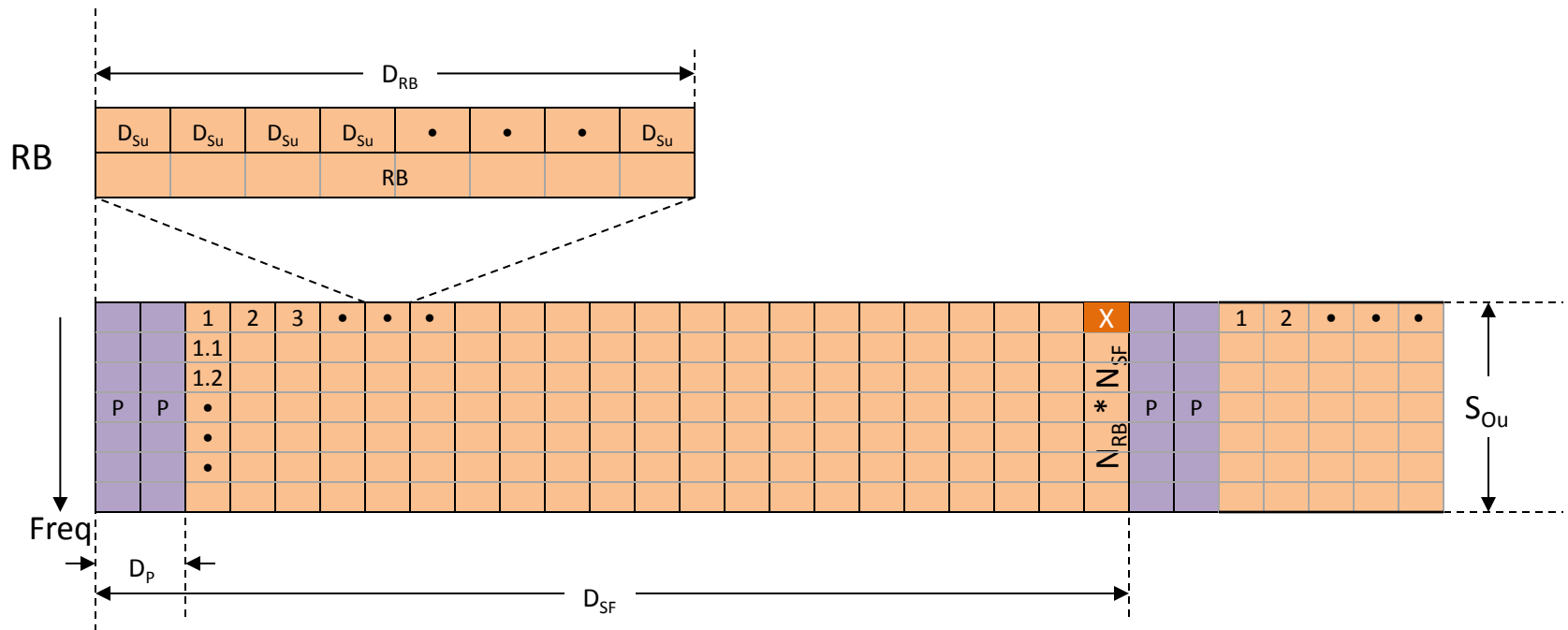
- OFDMA Frame numbering
  - Each OFDMA Frame (a column of RBs) is numbered using an integer
  - Individual Resource blocks within an OFDMA Frame can be referenced using a decimal if needed – numerated from lowest frequency to highest frequency

Superframe RBs Usage

- US Superframe RBs contains
  - Data RBs
  - Upstream PHY Link RBs
    - Including: PHY Discovery RBs and Fine Raging response RBs
- RB usage constraints
  - Number of MAC data resources in a Superframe is constant for all Superframes
  - A SF may include either:
    - Data RBs and PHY Link
    - Data RBs and PHY Discovery RBs and PHY Link
    - Data RBs and Fine Ranging response RBs and PHY Link
  - Number of resources consumed by US PHY Link plus PHY Discovery Window plus Fine Ranging response is constant for all Superframes
- RB usage parameters are set at network initialization
 - May differ between superframes with the above constraints

US PHY Link
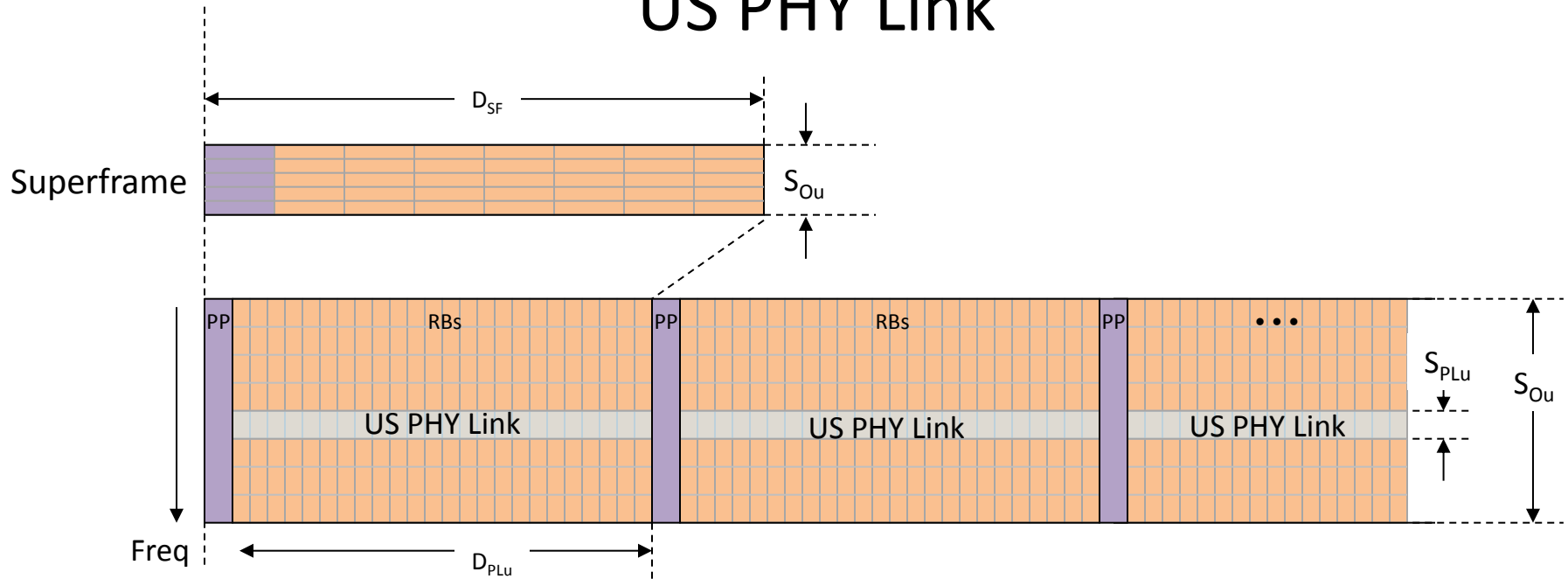
- **Upstream PHY Link frame Parameters**
  - Duration; $D_{PLu} = D_{SF} - D_P$
  - Spectrum; $S_{PLu} = N_{PLu} * S_{RB}$ (S_{PLu} is a constant [consider 400 kHz])
  - Starting SC is determined by parameter US PHY Link Start (Ref Cl 45.2.1.114) provisioned before network initialization
  - Not transmitted during Probe Symbols
  - Starting OFDMA Frame for any given US transmission indicated in DS PHY Link header
  - Volume; $V_{PLu} = (D_{SF} - D_P) * S_{PLu}$

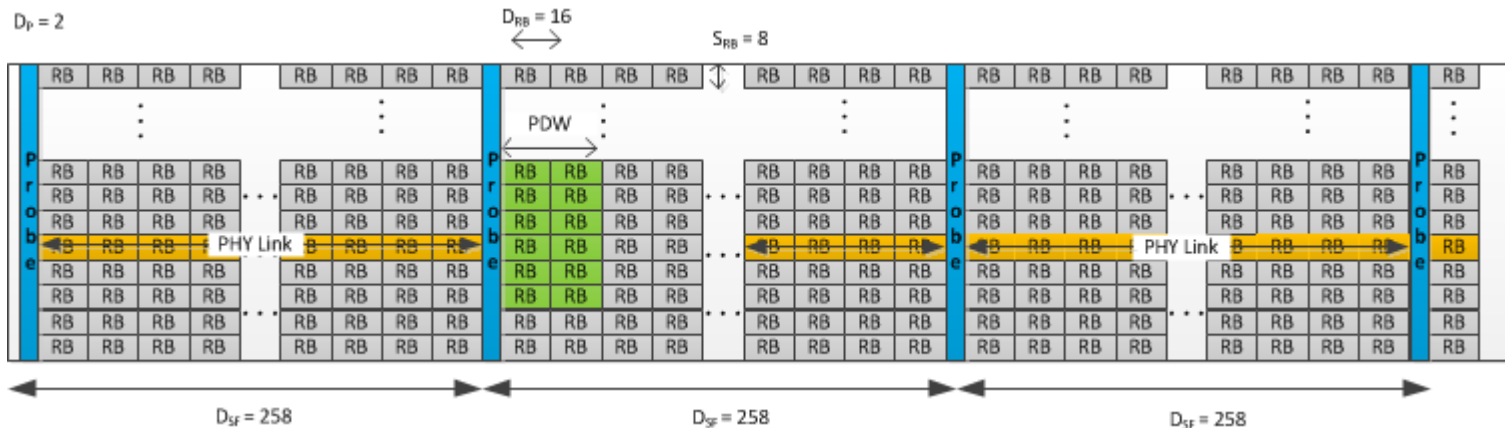# PHY Discovery Window Embedded in a Superframe
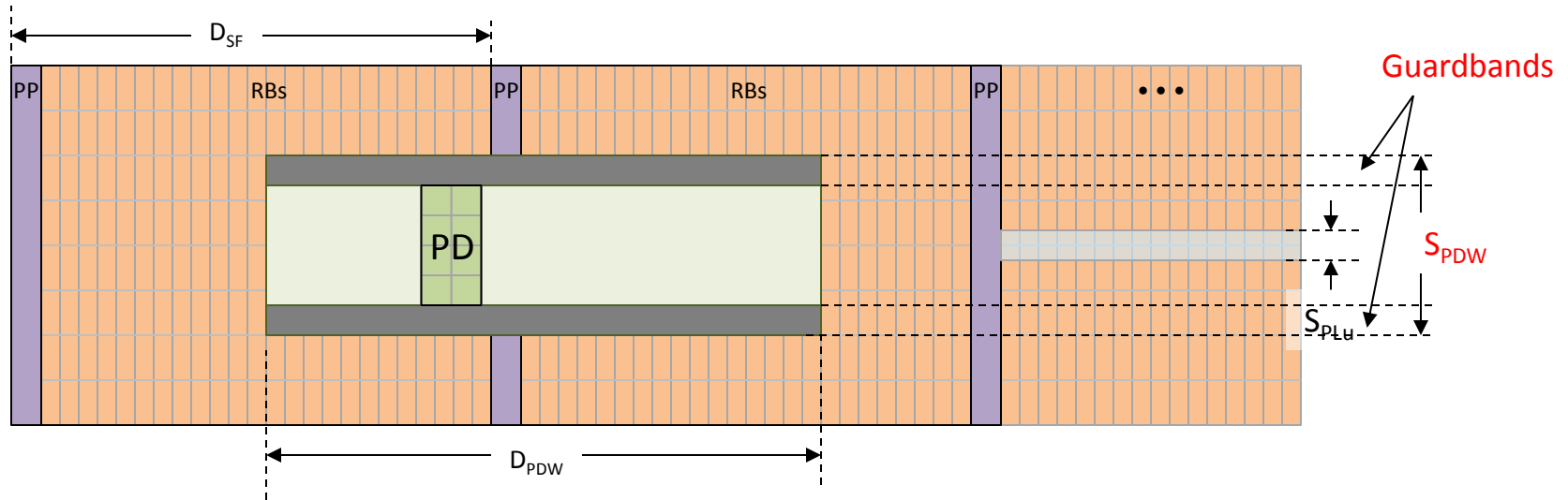
- PHY Discovery Window parameters
  - Duration; $D_{PDW} = N_{PDW} * D_{RB}$
    - determined by parameter PHY Discovery duration (Ref Cl 45.2.1.115)
  - Spectrum; -S_{PDW} fixed at TBD (48) * 50 kHz (inc. guard band)
  - Volume; $V_{PDW} = S_{PD} * D_{PDW}$ (may include an additional 2 symbols if overlapping Probes)
  - Starting Symbol is determined by parameter PHY Discovery start (Ref Cl 45.2.1.115)

Numerical Examples: PHY Discovery and US PLC with Superframe size of 254-258 Symbols
(new slide: replaces slides 12-14)

- PHY Discovery Window in a single Superframes
  - SF duration is between 5.5 mSec to 6.2 mSec
  - PDW durations >680 uSec

| D-PDW (uSec)	D-RB (symbols)	D-SF (symbols)	Dp (Symbols)	D-PDW (symbols)	S-PDW (SC)	S-PLu (SC)	V-PDW	V-PLu	D-PDW (Symbols)	D-PL (Symbols)
680	16	258	2	32	48	8	1536	2048	32	64
765	12	254	2	36	48	8	1728	2016	36	36
680	8	258	2	32	48	8	1536	2048	32	64

Superframe with D_{RB} = 16 and S_{RB} =8

Numerical Examples: PHY Discovery and US PLC with Superframe size of 254-258 Symbols
## (new slide: replaces slides 12-14)

- PHY Discovery Window spread over two Superframes
  - PDW durations of >1400 uSec

D-PDW (uSec)	D-RB (symbols)	D-SF (symbols)	Dp (Symbols)	D-PDW (symbols)	S-PDW (SC)	S-PLu (SC)	V-PDW	V-PLu	D-PDW 1 (Symbols)	D-PDW 2 (Symbols)	D-PLu1 (Symbols)	D-PLu2 (Symbols)
1402.5	16	258	2	66	48	8	3168	2048	32	32	64	64
1572.5	12	254	2	74	48	8	3552	2016	36	36	36	36
1402.5	8	258	2	66	48	8	3168	2048	32	32	64	64
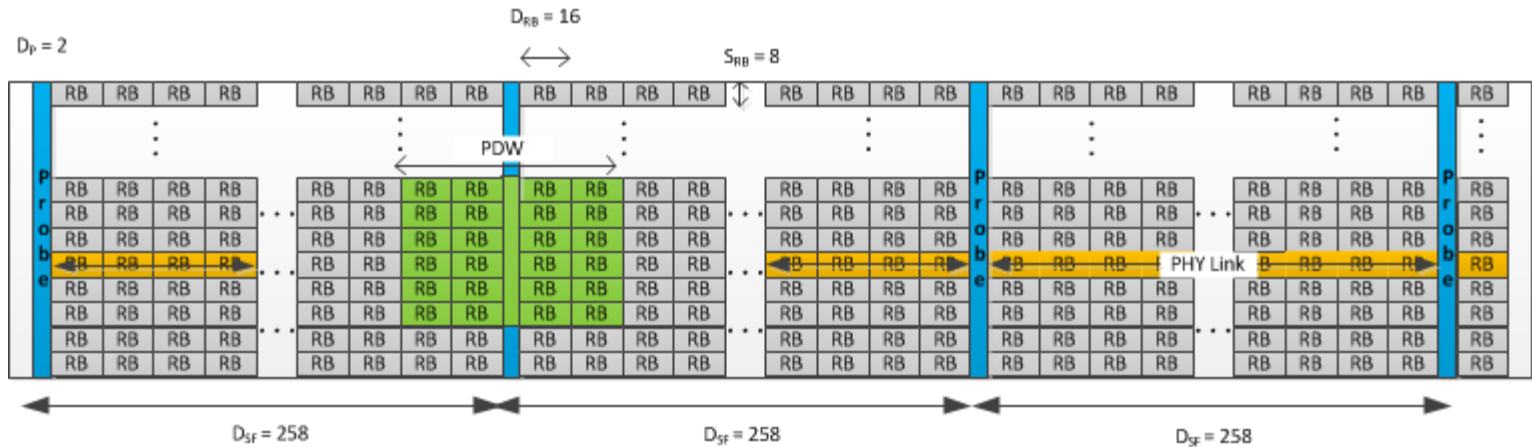
Superframe with D_{RB} = 16 and S_{RB} =8
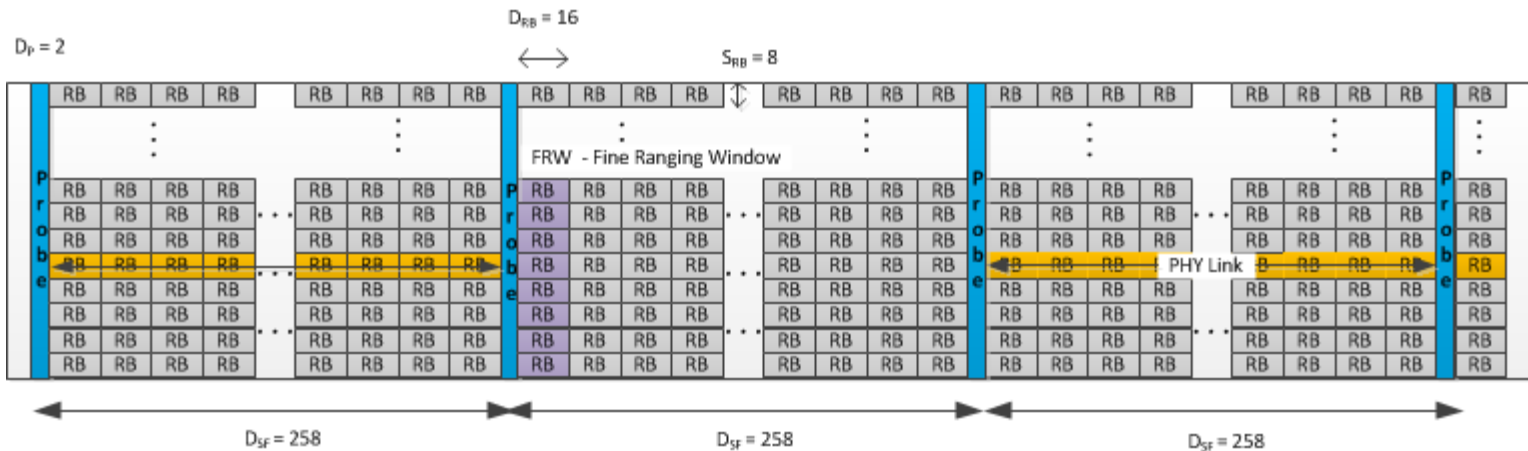
Fine Ranging Window
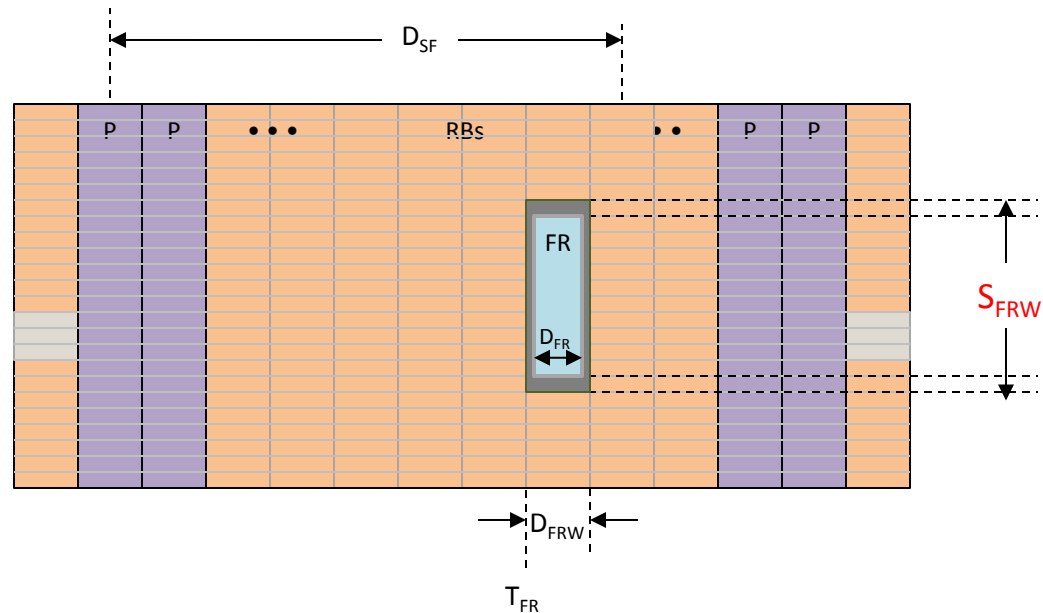
- Fine Ranging window parameters
  - Duration; fixed at $D_{FRW} = D_{RB}$ (8, 12 or 16 symbols)
  - Spectrum; fixed, between 6.4-8 MHz
  - Volume; $V_{FRW} = D_{FRW} * S_{FRW}$ (fixed per RB size and frame size)
  - Start; T_{FR} determined by a parameter passed over DS PHY Link
- Constraints
  - aligns to same boundary and placement conditions as RBs

Numerical Examples: Fine Ranging and US PLC with Superframe size of 254-258 Symbols
(a new slide)

- Fine Ranging Window spread requires a single Superframes

D-PDW (uSec)	D-RB (symbols)	D-SF (symbols)	Dp (Symbols)	D-FR (symbols)	S-FR (SC)	S-PLu (SC)	V-FR	V-PLu	D-PDW 1 (Symbols)	D-PLu1 (Symbols)
340	16	258	2	16	128	8	16	2048	16	0
255	12	254	2	12	160	8	12	2016	12	12
170	8	258	2	8	160	8	8	2048	8	96

Superframe with D_{RB} = 16 and S_{RB} =8

Superframe with all signals

<OR>

Not Shown:

D_{Su} – US Symbol duration

S_{RB} – Resource Block spectrum

Questions?

Comments?

THANK YOU

Motion

Adopt terms and definition for upstream Superframe described in slides 2-16 and incorporate in the draft.

Moved: Avi Kliger
Second: Duane Remein

For:
Against:
Abstain:

Motion is Technical (≥75%) Procedural (>50%)
Motion Passed/Failed