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LE RÉSEAU
ET LA SÉCURITÉ
INFORMATIQUE
SANS LIMITE !

Preamble Puncturing

Making wide channels work in the real world

Roméo DIAZ – CWNE #475

Interference is everywhere







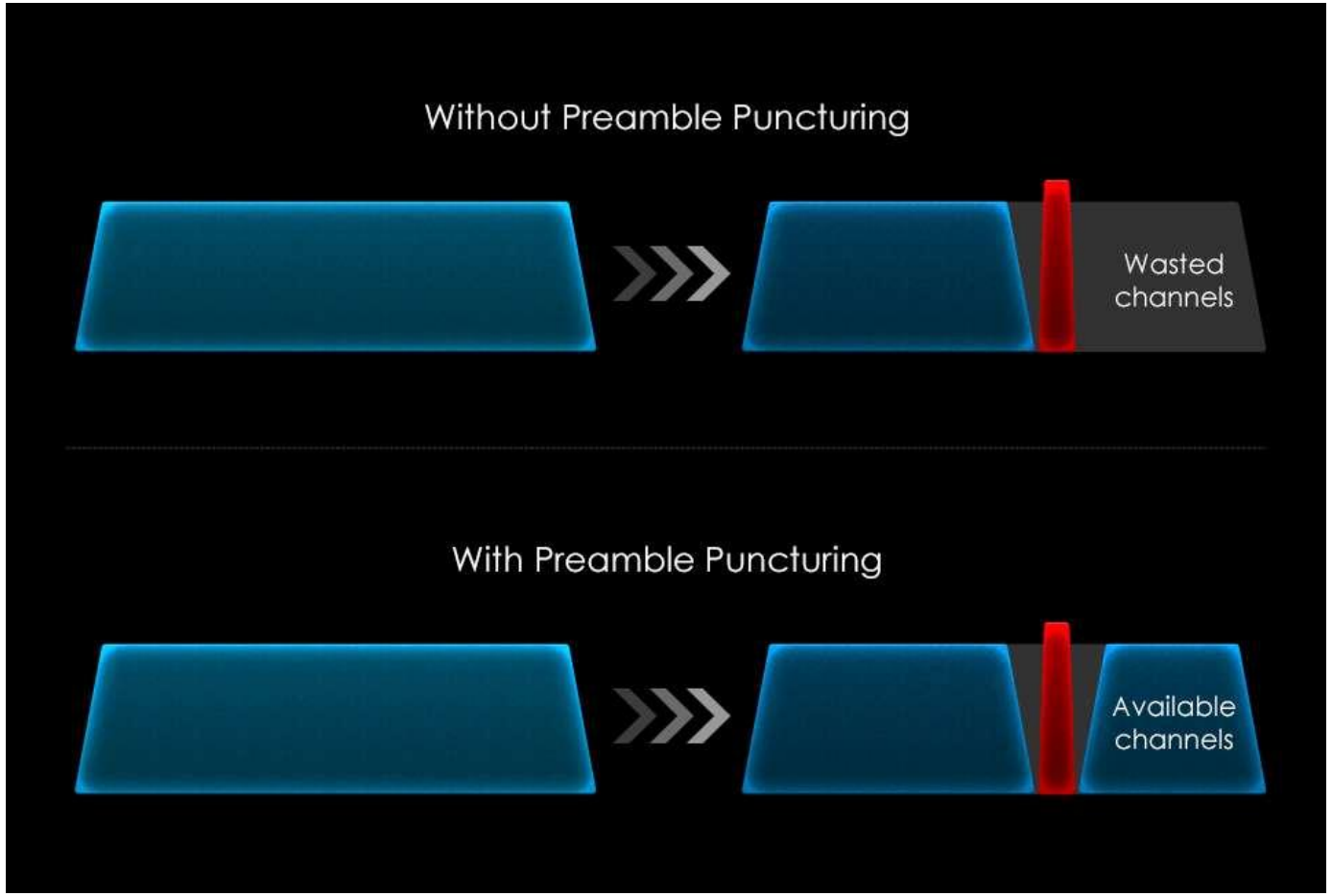






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Why Preamble Puncturing ?



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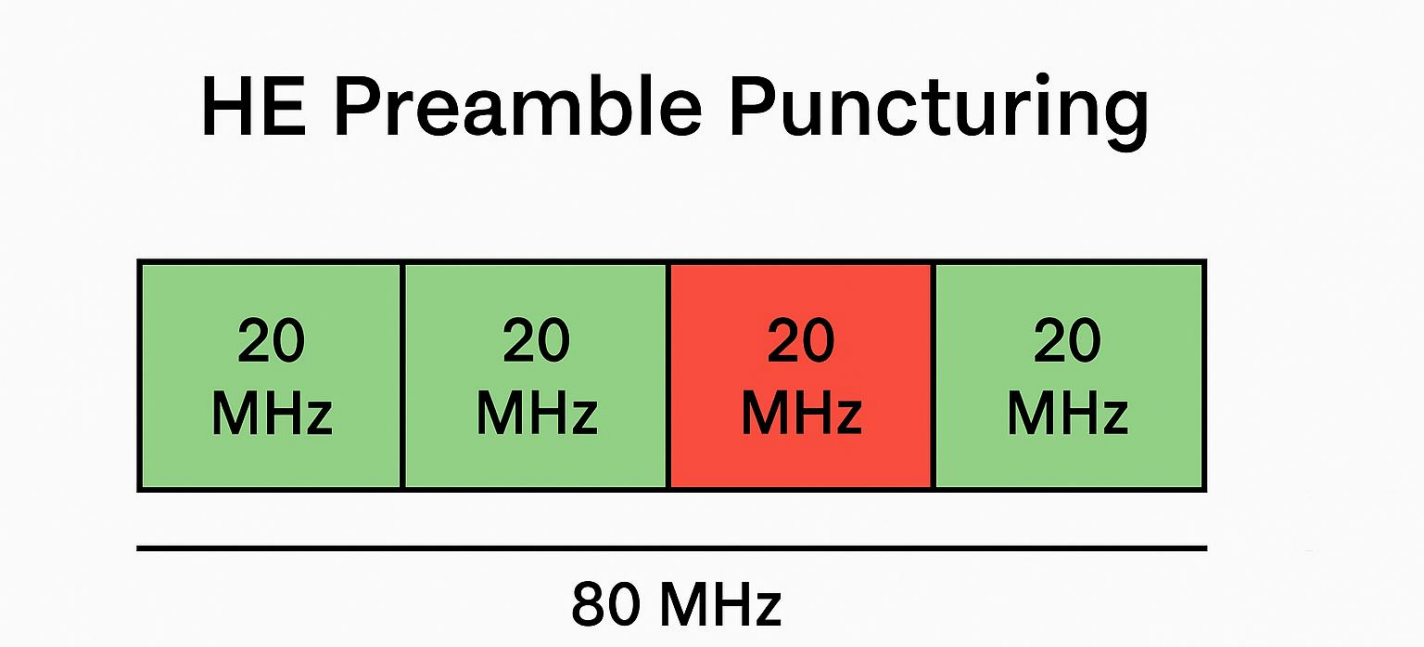
Before the Preamble Puncturing

How did we deal with interference?

	How it works	Limitation
Channel planning / RRM	Moves the AP to another channel	Slow and global, not adapted per transmission
Dynamic bandwidth	Reduces the transmission width when secondary channel is busy	Can discard large portions of otherwise usable spectrum
DFS	Leave a channel if a radar is detected	Radar-specific, not a solution for regular OBSS or interference

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Evolution of Preamble Puncturing



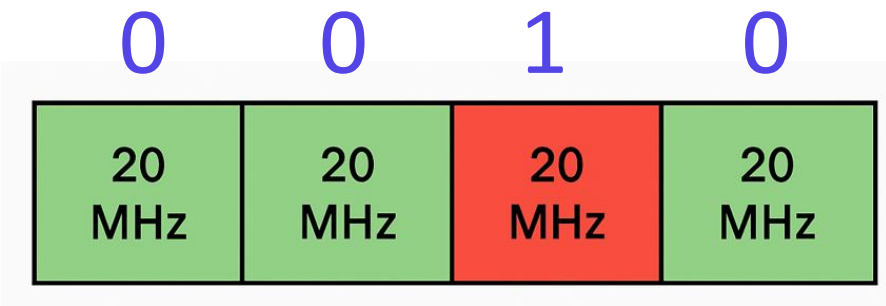
How it works ?

1 bit = 20 MHz

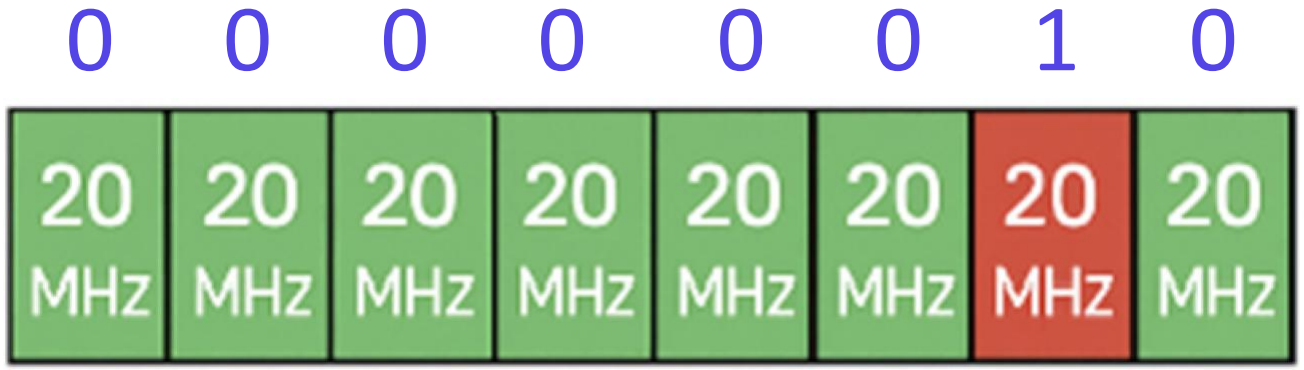
1 = punctured

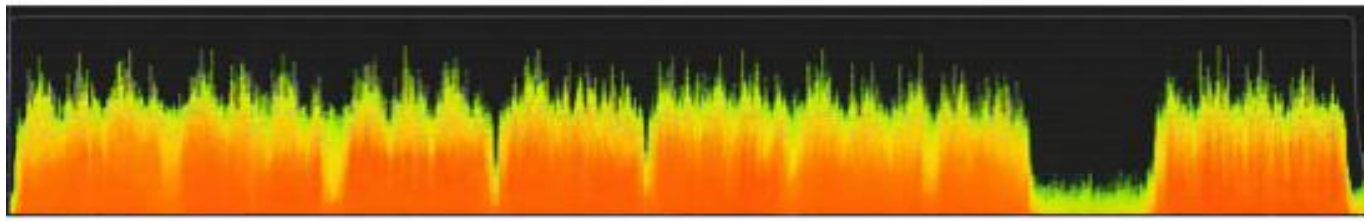
0 = available

80 MHz :



160 MHz :

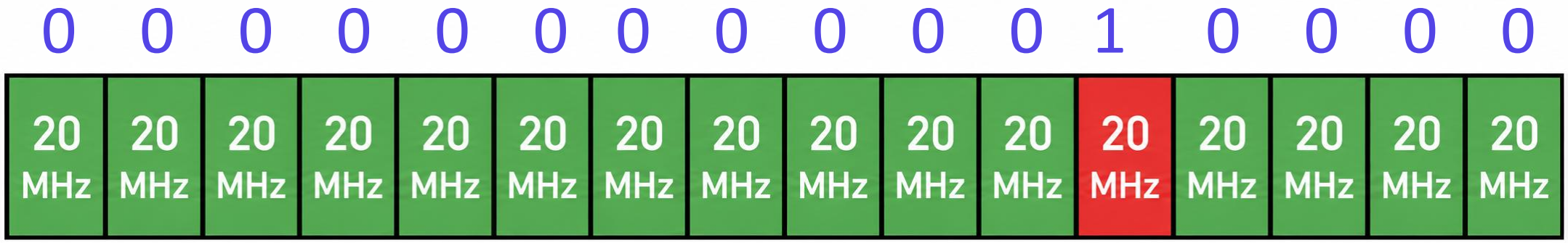




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How it works ?

320 MHz :



Two level of puncturing

BSS Level

- More structural
- Advertised in EHT Operation field
- 20 MHz granularity but need to respect a pattern

PPDU Level

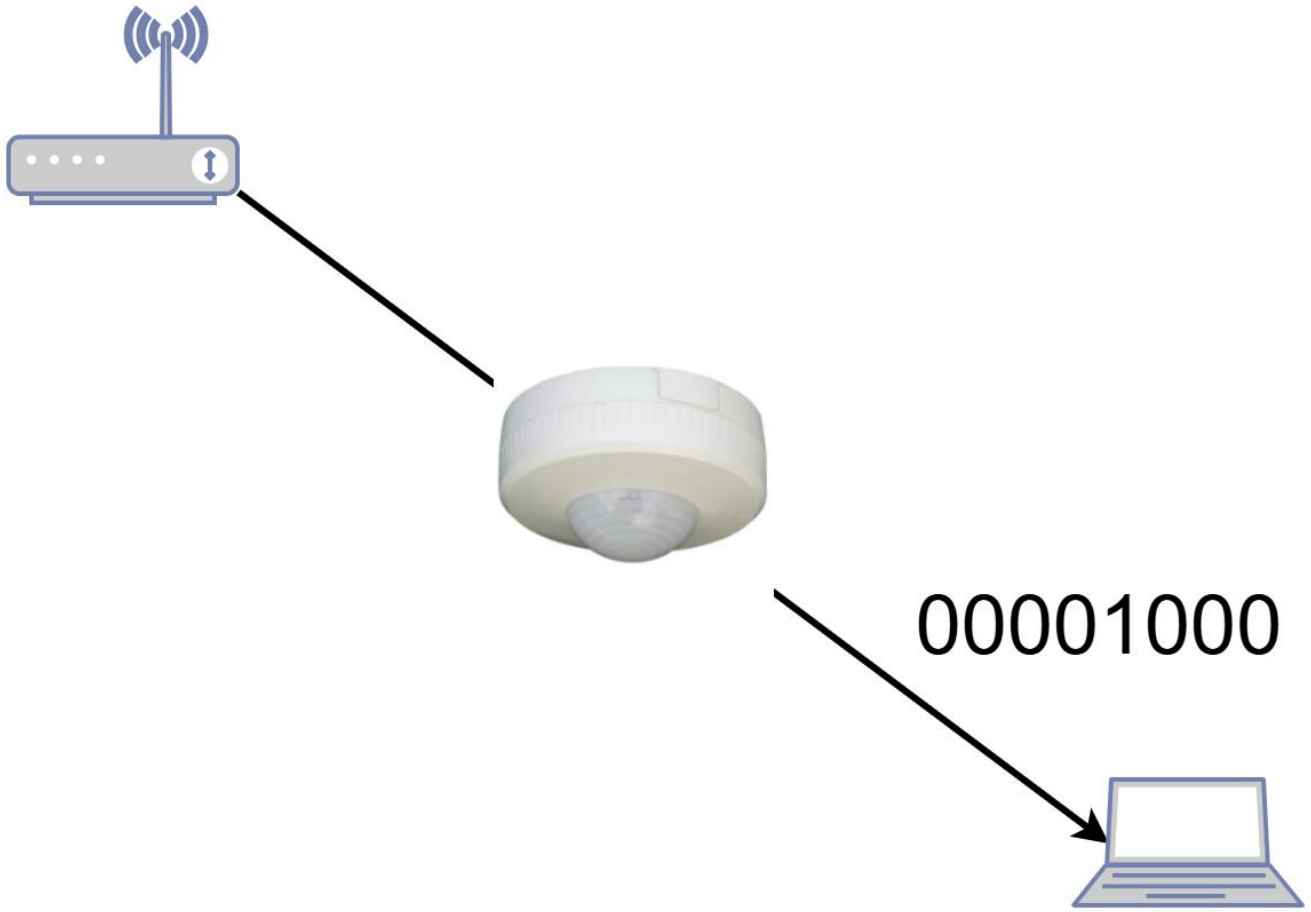
- Dedicated for one transmission
- Signaling depends on PPDU type
- Can only add new puncturing

Two complementary levels

The BSS defines the baseline, the PPDU can adapt further

Two level of puncturing

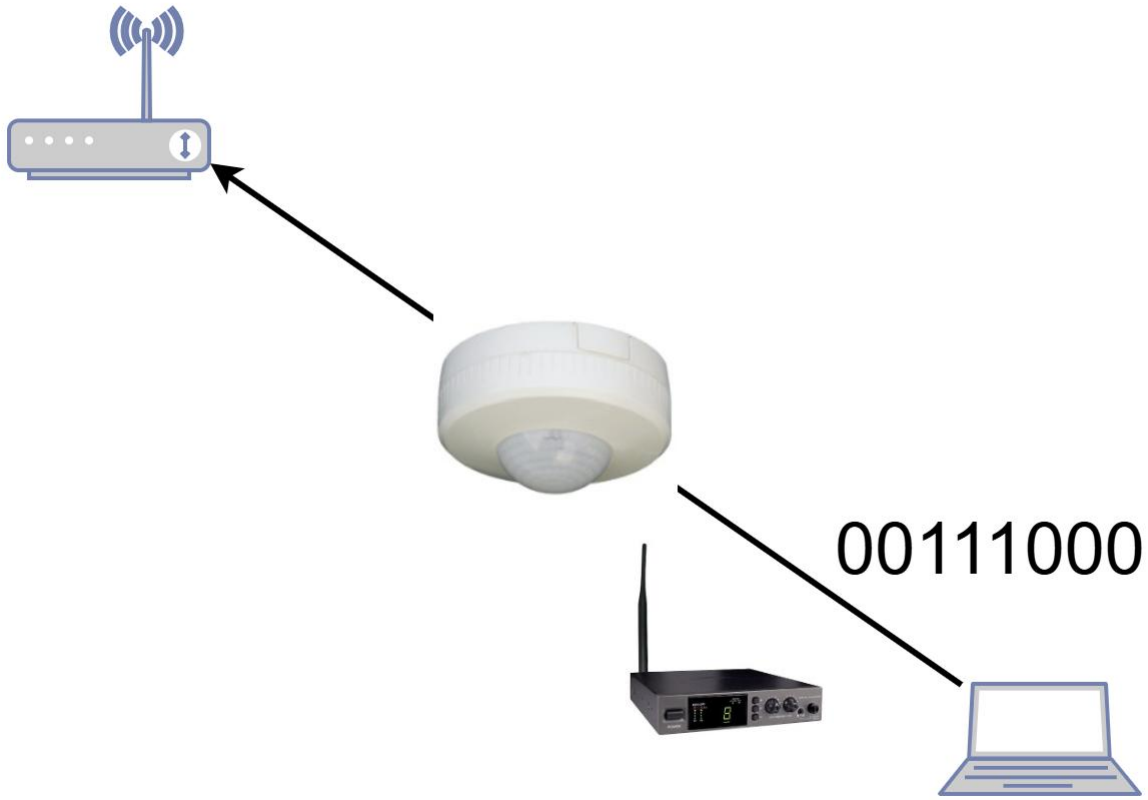
1



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Two level of puncturing

2



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Not every bitmap is a valid pattern

- Primary channel cannot be puncturing :



- Not every 20 MHz combination is allowed :



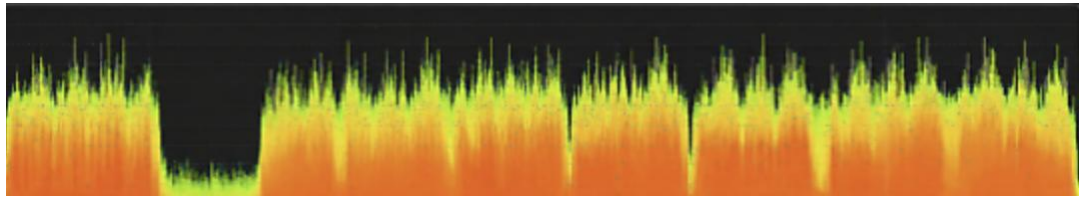
- 320 MHz non-OFDMA requires 40 MHz puncturing granularity :



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Signaling and structure

```
▾ Ext Tag: EHT Operation (802.11be D3.0)
    Ext Tag length: 10 (Tag len: 11)
    Ext Tag Number: EHT Operation (802.11be D3.0) (106)
  ▾ EHT Operation Parameters: 0x07, EHT Operation Information Present, Disabled Subchannel Bitmap Present, EHT Default PE Duration
      .... ...1 = EHT Operation Information Present: True
      .... ..1. = Disabled Subchannel Bitmap Present: True
      .... .1.. = EHT Default PE Duration: True
      .... 0... = Group Addressed BU Indication Limit: False
      ..00 .... = Group Addressed BU Indication Exponent: 0
      00.. .... = Reserved: 0x0
    Basic EHT-MCS And Nss Set: 0x00000011
  ▸ Control: 0x03, Channel Width: 160 MHz EHT BSS bandwidth
    CCFS0: 0x0000006a
    CCFS1: 0x00000072
    Disabled Subchannel Bitmap: 0x0002
```



00000010



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Real (in lab) performance

A scenario with a channel width of 160 MHz and interference occurring 20 MHz further on

	Available bandwidth	Maximum throughput	Flow loss
Without PP	Delayed	0Mb/s*	
With Dynamic bandwidth	80MHz	497Mb/s	52%
With PP	140MHz	1,29Gb/s	8%

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Who will be interested ?

Good candidate to enable the PP

- 80MHz minimum channel bandwidth
- Most client are Wi-Fi 7

Enable and monitoring the user experience

- Mixed Wi-Fi 6/7 environnement

Not recommended as it offers no benefit

- Most clients are older than Wi-Fi 6
- Heterogeneous client population
- 40 or 20 MHz bandwidth

Limitations and future evolutions

- Fixed granurality, only predefined patterns are allowed
- Primary channel cannot be punctured
- Limitation related to 320MHz
  - 40MHz granularity for non-OFDMA PPDU
- No real complementary mechnisms with MLO

Key Takeaway

- Preamble Puncturing does not create more spectrum
- It prevents clean spectrum from being wasted
- Its value increases as channels get wider

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THANK YOU !

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