**3GPP TSG RAN WG1#104-e R1-2xxxxxx**

**e-Meeting, January 25th – February 5th, 2021**

**Agenda Item: 8.2.2**

**Source: Moderator (none)**

**Title: [Draft] PDCCH Monitoring Alternatives**

**Document for: Discussion, Decision**

# Discussion on PDCCH Monitoring Alternatives

## Current version (as of Tuesday 01:05 UTC) – with markup

* Alt 1: A fixed pattern of X slots.
	+ The different X slot groups are consecutive and do not overlap
	+ PDCCH could be configured in ~~the first~~ Y consecutive slots within each X slot group
	+ BD/CCE budget is counted within the Y slots of each X slot group, ~~and different X slot groups do not overlap~~
	+ Alt 1-1: Y<X~~, BD/CCE budget is counted within the first Y slots of each X slot group, and the X slot groups do not overlap for different countings.~~
		- FFS: The Y slots are the first Y slots within the X slot group or not
	+ Alt 1-2: Y=X~~, BD/CCE budget is counted for each X=Y slot group, and the X slot groups do not overlap for different countings.~~
	+ Note: Y is used to facilitate discussion. If Alt 1-2 is agreed, Y is not needed.
* Alt 2: Use (X,Y) similar to the Rel-16 capability (*pdcch-Monitoring-r16*, (X, Y) span) as the baseline to define the new capability
	+ Y<=X
	+ PDCCH could be configured such that the developed span pattern by SS configuration satisfy (X,Y) requirement, i.e. the start of any two span of at most Y symbols/slots is separated by at least X symbols/slots
	+ BD/CCE budget is counted for each span of at most Y symbols/slots
	+ FFS: Values of X and Y and units in which they are defined
	+ ~~FFS: Whether number of slots within which the number of monitoring occasions is counted is needed and if needed, the value of the number of slots~~
* Alt 3: A sliding window of X=Y slots for defining multi-slot PDCCH monitoring capability.
	+ The slot groups are sliding in unit of [1] slot
	+ PDCCH could be configured in any slot
	+ BD/CCE budget is counted within any slot group ~~consecutive X=Y slots~~
	+ ~~FFS: Increments in which sliding occurs~~

## Clean version (as of Tuesday 1:05 UTC)

* Alt 1: A fixed pattern of X slots.
	+ The different X slot groups are consecutive and do not overlap
	+ PDCCH could be configured in Y consecutive slots within each X slot group
	+ BD/CCE budget is counted within the Y slots of each X slot group
	+ Alt 1-1: Y<X
		- FFS: The Y slots are the first Y slots within the X slot group or not
	+ Alt 1-2: Y=X
	+ Note: Y is used to facilitate discussion. If Alt 1-2 is agreed, Y is not needed.
* Alt 2: Use (X,Y) similar to the Rel-16 capability (*pdcch-Monitoring-r16*, (X, Y) span) as the baseline to define the new capability
	+ Y<=X
	+ PDCCH could be configured such that the developed span pattern by SS configuration satisfy (X,Y) requirement, i.e. the start of any two span of at most Y symbols/slots is separated by at least X symbols/slots
	+ BD/CCE budget is counted for each span of at most Y symbols/slots
	+ FFS: Values of X and Y and units in which they are defined
* Alt 3: A sliding window of X=Y slots for defining multi-slot PDCCH monitoring capability.
	+ The slot groups are sliding in unit of [1] slot
	+ PDCCH could be configured in any slot
	+ BD/CCE budget is counted within any slot group

## Update from Ericsson

* Alt 1: A fixed pattern of contiguous slot groups.
	+ Each slot group consists of X slots
	+ PDCCH monitoring can be configured in Y consecutive slots within each X slot group
	+ BD/CCEs are counted toward the budget within the Y slots of each X slot group
		- Note: BD/CCEs are not counted across slot group boundaries
	+ Alt 1-1: Y<X
		- FFS: Whether or not the Y slots are the first Y slots within each X slot group
	+ Alt 1-2: Y=X
		- Note: Y is used to facilitate discussion. If Alt 1-2 is agreed, Y is not needed.
* Alt 2: Use (X,Y) similar to the Rel-16 capability (*pdcch-Monitoring-r16*, (X, Y) span) as the baseline to define the new capability
	+ Y<=X
	+ PDCCH monitoring can be configured such that the span pattern by search space configuration satisfies the (X,Y) requirement, i.e. X is the minimum time separation between the the start of two consecutive spans, including across slot groups
	+ BD/CCEs are counted toward the budget for each span of at most Y symbols/slots
	+ FFS: Values of X and Y and units in which they are defined
* Alt 3: Same as Alt-1-2 (Y=X), except
	+ BD/CCEs are counted toward the budget within an X slot sliding window that can cross a slot-group boundary
	+ The window slides in unit of [1] slot
	+ PDCCH monitoring can be configured in any slot within a slot group

Comments:

* For Alt-1, I modified the first two lines to make it more clear that the pattern is not X slots. Rather, the pattern consists of contiguous slot groups where each slot group consists of X slots
* For Alt-2, aligned the wording to be close to what is in he current 38.213 Section 10, However, what was missing from the Alt-2 description is the implicit sliding window. So I added "including across slot groups" analogous to current 38.213

A UE can indicate a capability to monitor PDCCH according to one or more of the combinations $\left(X,Y\right)$ = (2, 2), (4, 3), and (7, 3) per SCS configuration of $µ=0$ and $µ=1$. A span is a number of consecutive symbols in a slot where the UE is configured to monitor PDCCH. Each PDCCH monitoring occasion is within one span. If a UE monitors PDCCH on a cell according to combination $\left(X,Y\right)$, the UE supports PDCCH monitoring occasions in any symbol of a slot with minimum time separation of $X$ symbols between the first symbol of two consecutive spans, including across slots. A span starts at a first symbol where a PDCCH monitoring occasion starts and ends at a last symbol where a PDCCH monitoring occasion ends, where the number of symbols of the span is up to $Y$.

* Question to all: I'm not convinced that the following is accurate. What happens if there are two spans within a slot group that satisfy the (X,Y) requirement? Is it necessary to introduce a third variable N = number of slots in slot group?

"BD/CCEs are counted toward the budget for each span of at most Y symbols/slots"

## Update from vivo

* Alt 1: A fixed pattern of X slots.
	+ The different X slot groups are consecutive and do not overlap
	+ PDCCH could be configured in Y consecutive slots within each X slot group
	+ BD/CCE budget is counted within the Y slots of each X slot group
	+ Alt 1-1: Y<X
		- FFS: The Y slots are the first Y slots within the X slot group or not
	+ Alt 1-2: Y=X
	+ Note: Y is used to facilitate discussion. If Alt 1-2 is agreed, Y is not needed.
* Alt 2: Use (X,Y) similar to the Rel-16 capability (*pdcch-Monitoring-r16*, (X, Y) span) as the baseline to define the new capability
	+ Y<=X
	+ PDCCH could be configured such that the developed span pattern by SS configuration satisfy (X,Y) requirement, i.e. the start of any two consecutive span of at most Y symbols/slots is separated by at least X symbols/slots
	+ BD/CCE budget is counted for each span of at most Y symbols/slots
	+ FFS: Values of X and Y and units in which they are defined
	+ FFS: Whether number of slots within which ~~the number of monitoring occasions is counted~~ the span pattern is repeated is needed and if needed, the value of the number of slots
* Alt 3: A sliding window of X=Y slots for defining multi-slot PDCCH monitoring capability.
	+ The slot groups are sliding in unit of [1] slot
	+ PDCCH could be configured in any slot
	+ BD/CCE budget is counted within any slot group

Comments:

* For Alt-1, it seems that we already have common understanding on this. The wording refinement from Ericsson is also fine with us.
* For Alt-2, I think the original FFS is still needed but the wording should be adjusted to make it clearer. In single-slot monitoring capability defined in NR Rel-15/16, the multi-symbol span pattern is repeated every slot and there may be multiple spans within one slot. Similarly, to define multi-slot monitoring capability, the multi-symbol/slot span pattern should be repeated in multiple (e.g. M, M>X>=Y) slots. One example could be that the span pattern is repeated in every subframe. Then N is actually the number of slots within which the span pattern is repeated, which is updated as above.
* For Alt-3, it is similar to Alt 1-2 except the BD/CCE counting.

In all the above alternatives, the above mentioned Y slots doesn’t mean all symbols in the slot are monitored. Which symbol needs to be monitored will be further discussed.