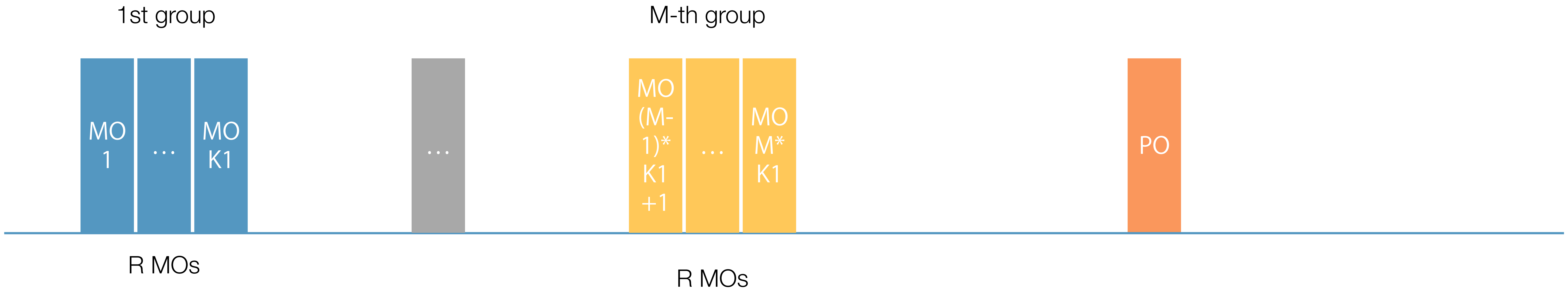
Proposal 1-7

- Option A: K LP-WUS MOs for a beam are divided into M groups of K1 LP-WUS MOs.
  - For each group of K1 LP-WUS MOs, the same LP-WUS is transmitted.
  - Different LP-WUS can be transmitted in different groups of K1 LP-WUS MOs.
  - FFS: UE monitoring behavior.
  - FFS K1=1 or K1>= 1
- Option B: K LP-WUS MOs for a beam are divided into K2 groups of K1*M LP-WUS MOs. A UE monitors one group of K1*M LP-WUS MOs based on its subgroup ID.
  - Each group of K1*M LP-WUS MOs is further divided into M groups of K1 LP-WUS MOs.
    - For each group of K1 LP-WUS MOs, the same LP-WUS is transmitted.
    - Different LP-WUS can be transmitted in different groups of K1 LP-WUS MOs.
    - FFS: UE monitoring behavior.
  - FFS K1=1 or K1>=1
  - K2>=1
  - Note: this achieves the same purpose as "Option 3: UEs monitoring the same PO are divided into multiple sets of subgroups, with UEs within each set of subgroups monitoring the same LO."

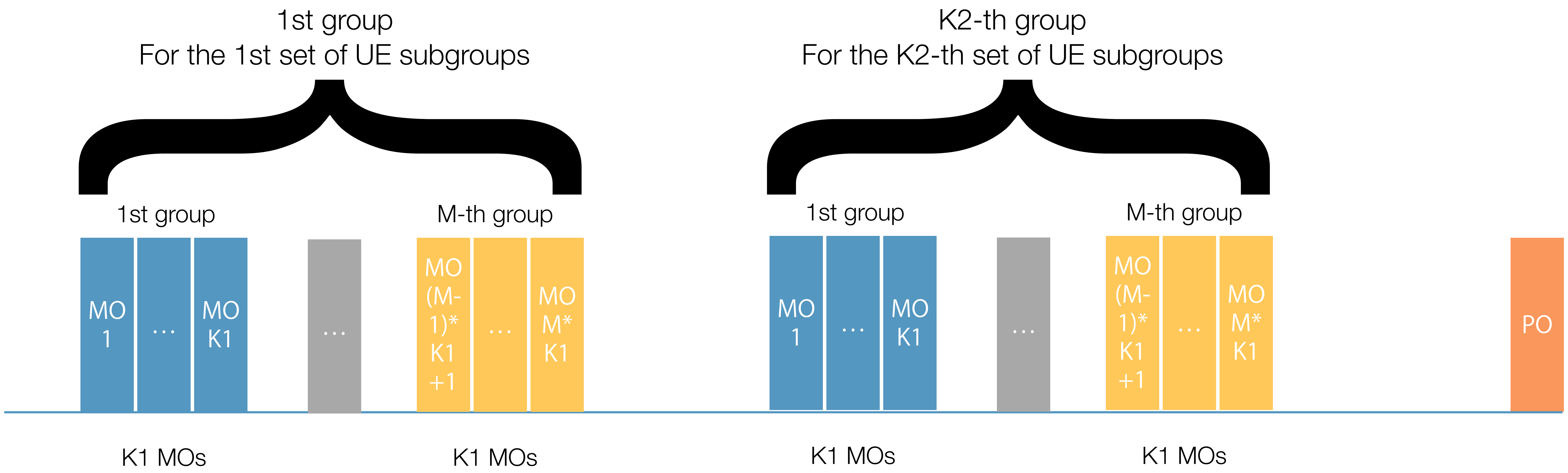
Option A

- Option A: K LP-WUS MOs for a beam are divided into M groups of R LP-WUS MOs.
  - For each group of R LP-WUS MOs, the same LP-WUS is transmitted.
  - Different LP-WUS can be transmitted in different groups of R LP-WUS MOs.
  - FFS: UE monitoring behavior.
  - FFS R=1 or R>= 1
  - M>=1
- The UE may assume that if LP-WUS is transmitted, the same LP-WUS is transmitted in the group of R LP-WUS MOs. -> This mandates the gNB to transmit all or none.
  - The UE is not required to monitor all R MOs in a group. It may monitor just 1 of the R MOs.



Option B

- Option B: K LP-WUS MOs for a beam are divided into K2 groups of K1*M LP-WUS MOs. A UE monitors one group of K1*M LP-WUS MOs based on its subgroup ID.
  - Each group of K1*M LP-WUS MOs is further divided into M groups of K1 LP-WUS MOs.
    - For each group of K1 LP-WUS MOs, the same LP-WUS [information] is transmitted.
    - Different LP-WUS can be transmitted in different groups of K1 LP-WUS MOs.
    - FFS: UE monitoring behavior.
  - FFS K1=1 or K1>=1
  - K2>=1
  - M>=1
  - Note: this achieves the same purpose as “Option 3: UEs monitoring the same PO are divided into multiple sets of subgroups, with UEs within each set of subgroups monitoring the same LO.”



Discussion on the Results in Companies Contributions

- [HW/Futurewei] To keep the FAR rate from noise <= 1%, LP-WUS needs >= [12] bits (plus Manchester coding) if UE needs to monitor 4 MOs, [9] bits for 1 MO.
- [HW/Futurewei] The FAR rate from a different code point is very low, lower than the FAR from noise. (R1-2403948 Appendix D, BER is obtained from the required BLER 1%)
- [HW/Futurewei] Assuming the same # of UEs and the same per-UE paging rate, different number of subgroups does not have much impact on the # of LP-WUS to be transmitted.
  - See Huawei’s comments in the summary for Question 2-1.
  - Reason: Majority LP-WUS transmission is to page a single UE.
- [vivo] Assuming the same # of UEs and the same per-UE paging rate, similar overhead is observed for different number of subgroups.
- LP-WUS duration stays the same regardless of the number of subgroups??

HW

- To achieve FAR <= 1%, 8-bit payload is needec
- Last row in the table
  - Per-UE paging rate 0.018%
  - N = 169 UEs per subgroup
  - M = 649519 UEs per TA
  - M / N = 3843
  - How many POs?
    - With 64 POs, 649519/64 = 10148 UEs per PO

Table 1 Required number of groups/subgroups to achieve effective paging rate <=3%

Number of sites per tracking area M (assuming ISD=500m)	Number of UEs per km²[4]	Required number of groups/subgroups, K	$\log_2 K$
500	10^6	$\sim 1.9*10^6$	~21
100	10^6	$\sim 3.8*10^5$	~19
500	10^4	$\sim 1.9*10^4$	~14
100	10^4	$\sim 3.8*10^3$	~12

In this appendix, we provide the detailed analyzes of required number of groups/subgroups to achieve effective paging rate <=3%.

L represents the ISD of a site. Assuming a hexagon shape of the coverage of a site, the area of a site is $\frac{3\sqrt{3}}{2}L^2$.

M represents the number of sites per tracking area, and ρ represents the density of UEs, then the number of UEs in a tracking area is $\frac{3\sqrt{3}}{2}L^2M\rho$.

According to the TR [1], the relationship between per group paging probability R_G and a per UE paging probability R_E is $R_G = 1-(1-R_E)^N$, where N is the number of UEs in the group. Thus, to achieve a target effective paging rate (i.e. the paging rate for a group/subgroup), $N = \log_{(1-R_E)}(1-R_G)$.

Then, the number of UEs per group/subgroup is $K = \frac{3\sqrt{3}L^2M\rho}{2\log_{(1-R_E)}(1-R_G)}$.

Vivo

Table 1 FAR_c caused by codepoint mapping and required number of MOs to meet FAR ≤ 1%

UE setting	FAR_c by single MO	The number of required LP-WUS MOs to meet $FAR_c \leq 1\%$
eMBB set 1	20.2%~30.8% for $N_{subgroup}$=8~256	[3 4 4 4 4 4] for $N_{subgroup}$=[8 16 32 64 128 256]
eMBB set 2	0.4%~0.6% for $N_{subgroup}$=8~256	[1 1 1 1 1 1] for $N_{subgroup}$=[8 16 32 64 128 256]
eMBB set 3	14.8%~22.5% for $N_{subgroup}$=8~256	[3 3 3 4 4 4] for $N_{subgroup}$=[8 16 32 64 128 256]
IoT set 1	4.1%~6.2% for $N_{subgroup}$=8~256	[2 2 2 2 2 2] for $N_{subgroup}$=[8 16 32 64 128 256]
IoT set 2	12.7%~19.3% for $N_{subgroup}$=8~256	[3 3 3 3 3 3] for $N_{subgroup}$=[8 16 32 64 128 256]

Table X setting cases for eMBB and IoT

Setting cases	**paging area size [cells]**	**UEs with LPWUS/km2**	**total number of UE in paging area**	**Number of PO**	**per UE paging rate**
eMBB set 1	10	5000	3600	32	1%
eMBB set 2	10	10000	7200	64	0.1%
eMBB set 3	10	10000	7200	8	0.1%
IoT set 1	2	1000000	144000	64	0.018%
IoT set 2	2	1000000	144000	32	0.018%