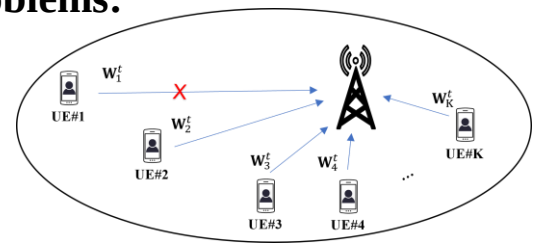
SYP351335 : A performance improvement and UE selection scheme based on sidelink enhancement in FL

1. Problems:



Global aggregation:

$$\mathbf{W}^{t+1} = \frac{1}{N}\sum_{k=1}^{K} U_k n_k \mathbf{W}_k^t \qquad N = \sum_{k=1}^{K} U_k n_k$$

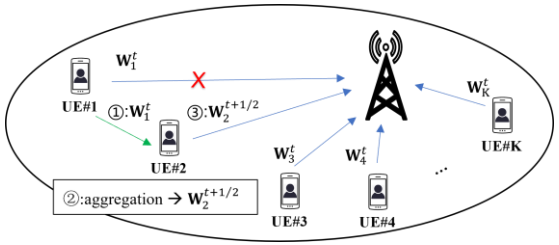
$$U_k = \begin{cases} 1, & successful\ transmission \\ 0, & otherwise \end{cases}$$

Unreliability: UEs may have failed transmissions

E.g., UE#1 failed transmission at round t → $\mathbf{W}_1^t$ does not contribute to the global aggregation.

2. Scenarios and Solutions:

Scenarios#1: UE pairs, one-way sidelink



①: UE#1 transmits $\mathbf{W}_1^t$ to UE#2 via sidelink

②: UE#2 does local model aggregation ---- $\mathbf{W}_2^{t+1/2} = \frac{1}{n_1+n_2}(n_1\mathbf{W}_1^t + n_2\mathbf{W}_2^t)$

③: UE#2 transmits $\mathbf{W}_2^{t+1/2}$ to gNB

Outage probability: q_1 for UE#1 & q_2 for UE#2

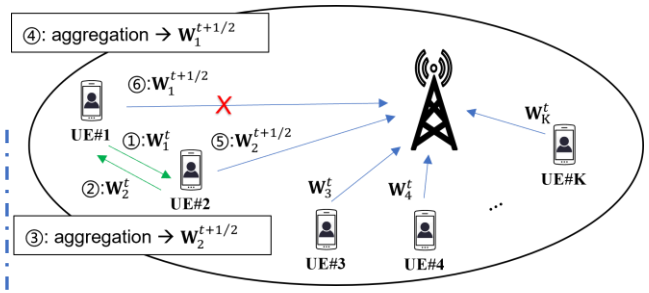
For UE#1: $\mathbf{W}_1^t$ contributes to global aggregation with probability:

No sidelink enhancement:$1 - q_1$

With sidelink enhancement:$1 - q_1 q_2 > 1 - q_1$

Define: global aggregation contribution probability

Scenarios#2: UE pairs, two-way sidelink

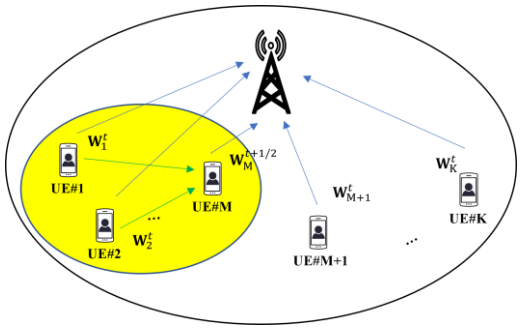


For UE#i (i=1,2): $\mathbf{W}_i^t$ contributes to global aggregation with probability:

No sidelink enhancement:$1 - q_i$

With sidelink enhancement:$1 - q_1 q_2 > 1 - q_i$

Scenarios#3: Centralized M-UE group

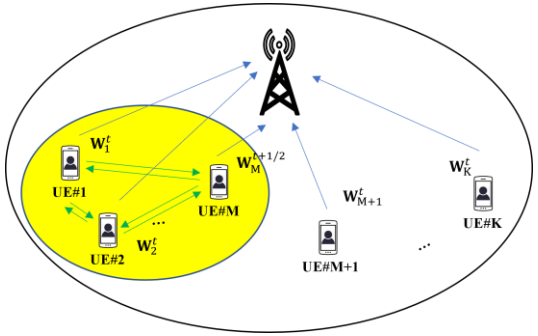


For UE#i (i=1,M-1): $\mathbf{W}_i^t$ contributes to global aggregation with probability:

No sidelink enhancement:$1 - q_i$

With sidelink enhancement:$1 - q_i q_M > 1 - q_i$

Scenarios#4: Dentralized M-UE group



For UE#i (i=1,M): $\mathbf{W}_i^t$ contributes to global aggregation with probability:

No sidelink enhancement:$1 - q_i$

With sidelink enhancement:

$$1 - \prod_{j=1}^{M} q_j > 1 - q_i$$

3. Standard impact:

1. **TR22.876:** Study on AI/ML Model Transfer-Phase 2
2. **3GPP R19 WID** "Study on AI/ML Model Transfer Phase 2" **(S1-221225):**

For Distributed Learning, controlled by network, each device uses the localized data while **transfer the intermediate data to other nodes** the device moves a certain coverage, has low power, or for combined computation for a big mode.

Objective: Distributed AI training/inference based on direct device connection, e.g. traffic KPIs, different QoS and functional requirements on **slidelink transmission**.

Contribution:

1. Broadcast the sidelink transmission results to other Ues
2. User constent
3. UE selection considering Sidelink ---- NEF expose the sidelink infos to Application (5GC)