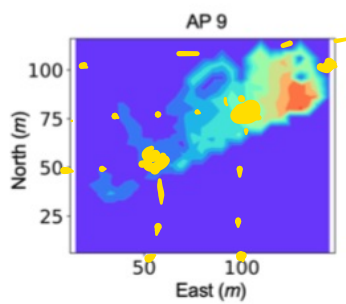
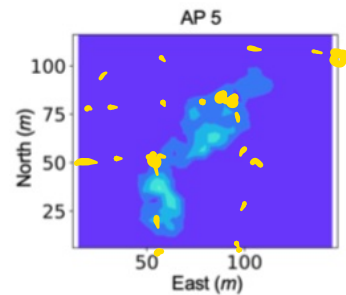
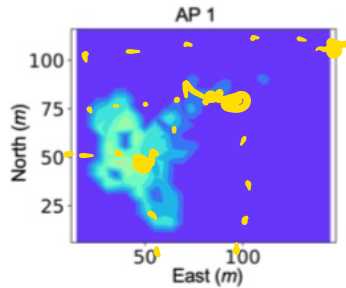


# Fingerprinting



Firma/Huella Digital

CDB (Base de Datos)

Servidor (Localización)

Reducción Búsqueda

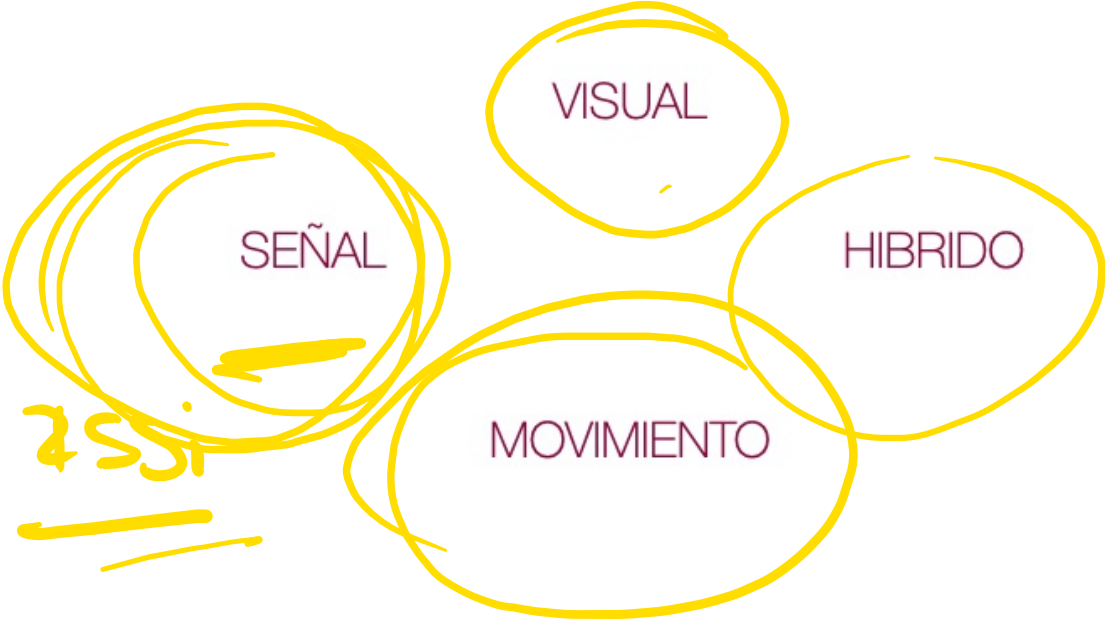
Comparación Patrones

RSSI, ID, Activo, Orient.

Firma, Posición



# Fingerprinting



Fingerprinting

$T_{FING} = \begin{bmatrix} ID_1 & RSS_1 \\ \vdots & \vdots \\ ID_N & RSS_N \end{bmatrix}$

↑  $ER_i$   
Pos.  $ER_i$

Firma que medís

$R_{FING_i} = \begin{bmatrix} ID_{i,1} & RSS_{i,1} \\ \vdots & \vdots \\ ID_{i,N} & RSS_{i,N} \end{bmatrix}$

BASE DE DATS

CBD:  $\{(\underline{x}, \underline{y}); \underline{R_{FING_i}}\}$

wifi  
MAC AP<sub>1</sub>, RSS<sub>1</sub>  
MAC AP<sub>2</sub>, RSS<sub>2</sub>

# Fingerprinting: Localización <-> Pattern Matching

$$\vec{T} = [T_{FING}(1, 2), \dots, T_{FING}(N, 2)]$$

$$\vec{R}_i = [R_{FING_i}(1, 2), \dots, R_{FING_i}(N, 2)]$$

$$R_{FING_i}(u, 1) = T_{FING}(u, 1)$$

$$\langle T, R_i \rangle = \sum x_i y_i$$

$$\langle T, R_i \rangle = \|T\| \|R_i\| \cdot \cos(\theta)$$

$$d = \frac{\langle T, R_i \rangle}{\|T\| \|R_i\|}$$

$$d = \min_{R_i} \frac{\langle T, R_i \rangle}{\|R_i\| \|T\|}$$

$$\underline{d} = |(\underline{T} - \underline{R}_i)(\underline{T} - \underline{R}_i)^T|$$

min  $\nearrow \rightarrow (x, y)$   
 $R_i$

Fingerprinting: Localización <-> Pattern Matching

$$d_{i,j} = \sqrt{\sum_{k=1}^N (T_{mk}^{\vec{}} - \vec{R}_{nk})^2 + 2\beta(N_a - N)}$$

Fingerprinting: Correlación por Nivel : SP = NORMAN Data Corp.

$\downarrow T$        $\downarrow Li$

$$\underline{V_t(n, 1)} = \underline{V_r(n, 1)} = ID_n$$

$$\underline{V_t(n, 2)} = \underline{V_r(n, 2)} = N_c$$

$$\rho = \frac{\sum_{n=1}^{N_c} (V_t(n, 2) - \bar{\rho}_t)(V_r(n, 2) - \bar{\rho}_r)}{\sqrt{\sum_{n=1}^{N_c} (V_t(n, 2) - \bar{\rho}_t)^2 \sum_{n=1}^{N_c} (V_r(n, 2) - \bar{\rho}_r)^2}}$$

$$\bar{\rho}_t = \frac{1}{N_c} \sum_{n=1}^{N_c} V_t(n, 2)$$

$$\bar{\rho}_r = \frac{1}{N_c} \sum_{n=1}^{N_c} V_r(n, 2)$$

- Two's distinct 2SSi are el for

- sample per measurement to  
dif. relot.

$T_0$  ~~1000~~  $\rightarrow$  —

|               |                                    |       |       |
|---------------|------------------------------------|-------|-------|
| $AP_1 > AP_2$ | $AP_1 \rightarrow -45 \text{ dBm}$ | $-47$ | $-50$ |
|               | $AP_2 \rightarrow -77 \text{ dBm}$ | $-75$ | $-78$ |



$$V_t(n, 1) = V_r(n, 1) = ID_n$$

$$V_t(n, 2) = V_r(n, 2) = N_c$$

$$\rho = \frac{\sum_{n=1}^{N_c} (V_t(n, 2) - \bar{\rho}_t)(V_r(n, 2) - \bar{\rho}_r)}{\sqrt{\sum_{n=1}^{N_c} (V_t(n, 2) - \bar{\rho}_t)^2 \sum_{n=1}^{N_c} (V_r(n, 2) - \bar{\rho}_r)^2}}$$

$$\rho = 0.69$$

Fingerprinting: Correlación por Nivel

$$T_{FING} = \begin{bmatrix} 100 & 110 & 2 & 5 & 99 \\ 62 & 60 & 54 & 43 & 40 \end{bmatrix}$$

IP  
TOT

$$R_{FING} = \begin{bmatrix} 100 & 5 & 110 & 111 & 10 & 200 & 201 \\ 54 & 50 & 49 & 45 & 34 & 30 & 29 \end{bmatrix}$$

IP  
TOT

$$V_T = \begin{bmatrix} 2 & 5 & 10 & 99 & 100 & 110 & 111 & 200 & 201 \\ 3 & 4 & 9 & 5 & 1 & 2 & 9 & 9 & 1 \end{bmatrix}$$

$N_C = 9$

$$\bar{f}_T = \frac{1}{9} (3 + 4 + 9 + 5 + 1 + 2 + 9 + 9 + 9) = 5.7$$

$$V_R = \begin{bmatrix} 2 & 5 & 10 & 99 & 100 & 110 & 111 & 200 & 201 \\ 9 & 2 & 5 & 9 & 1 & 3 & 4 & 6 & 7 \end{bmatrix}$$

$\bar{f}_R = 5.1$

## Fingerprinting: Reducción del espacio de búsqueda

$$1 - T(1,1) = R(1,1)$$

2 = un número mínimo de ~~tr~~  
operaciones comp.

$$- T(1,i) = R(1,i) \quad , \quad i \in [1,n]$$

$i=2, 3$

~~Restar los firmas~~  $\rightarrow$  10 s

# Fingerprinting: Estimación como Promedio (KNN - MAF - KNN Probabilístico)

1 Fingerprint  $\rightarrow$  Pos  $\rightarrow$  Pos de la Fingerprint

$$(\hat{x}, \hat{y}) = \frac{\sum (x_i, y_i)}{k}$$

$$(\hat{x}, \hat{y}) = \frac{\sum w(x_i, y_i)}{k}$$

$$\frac{1}{k}$$

$$\sum \frac{p(x) (x_i, y_i)}{k}$$

MA

given  $L$  medication over  $t$  hrs

$$(\hat{x}, \hat{y}) = \frac{\sum_i^L (x_i, y_i)}{L}$$

Ejercicio a entregar!



10m  
Línea  
1 mudo  
de AP  
y GPS

- 3 records equal
  - en C/U tower 10 minutes
  - tower 2 records pour la BD
- $\left. \begin{array}{l} \downarrow \\ \downarrow \end{array} \right\} 2 \left[ \left( \text{PAST, LONG} \right) - \left[ \text{ID, ZSSI, } \dots \right] \right]$
-

TRANSFORMAR LAT Y LONG  
en COORDENADAS UTM



- el ultimo elemento lo usamos  
para localizar.



$(X_{11}) \rightarrow (A_1)$

