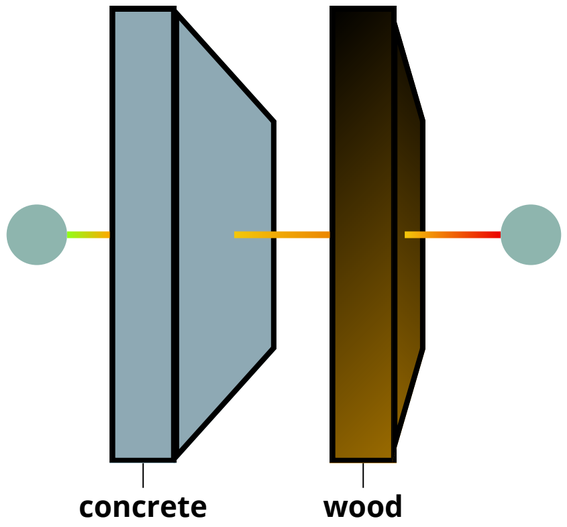
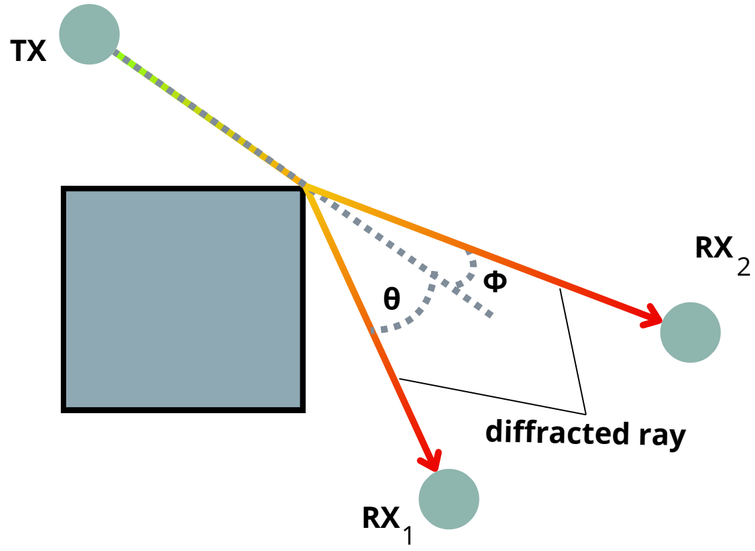
Incorporating Building Topology for Context-Aware Path Loss modeling in ns-3

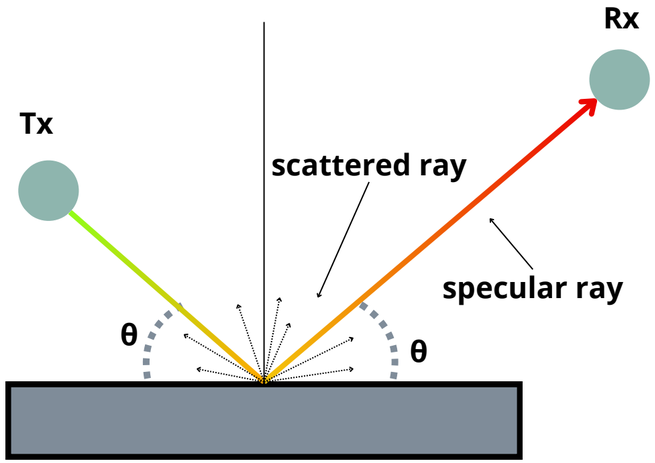
Penetration



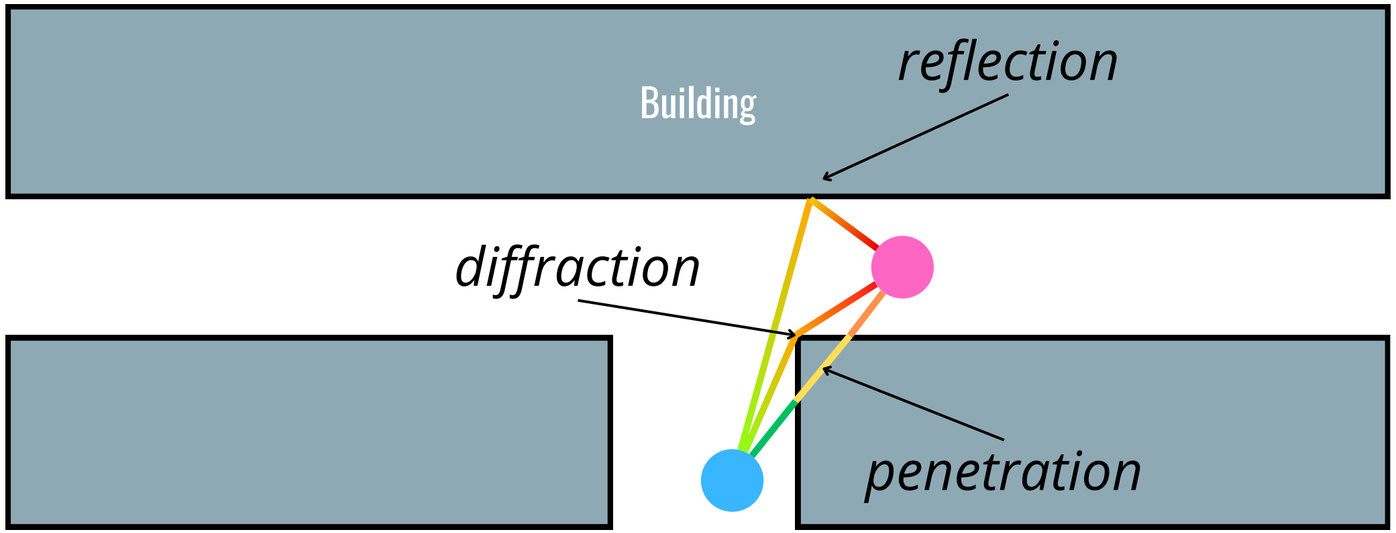
Diffraction



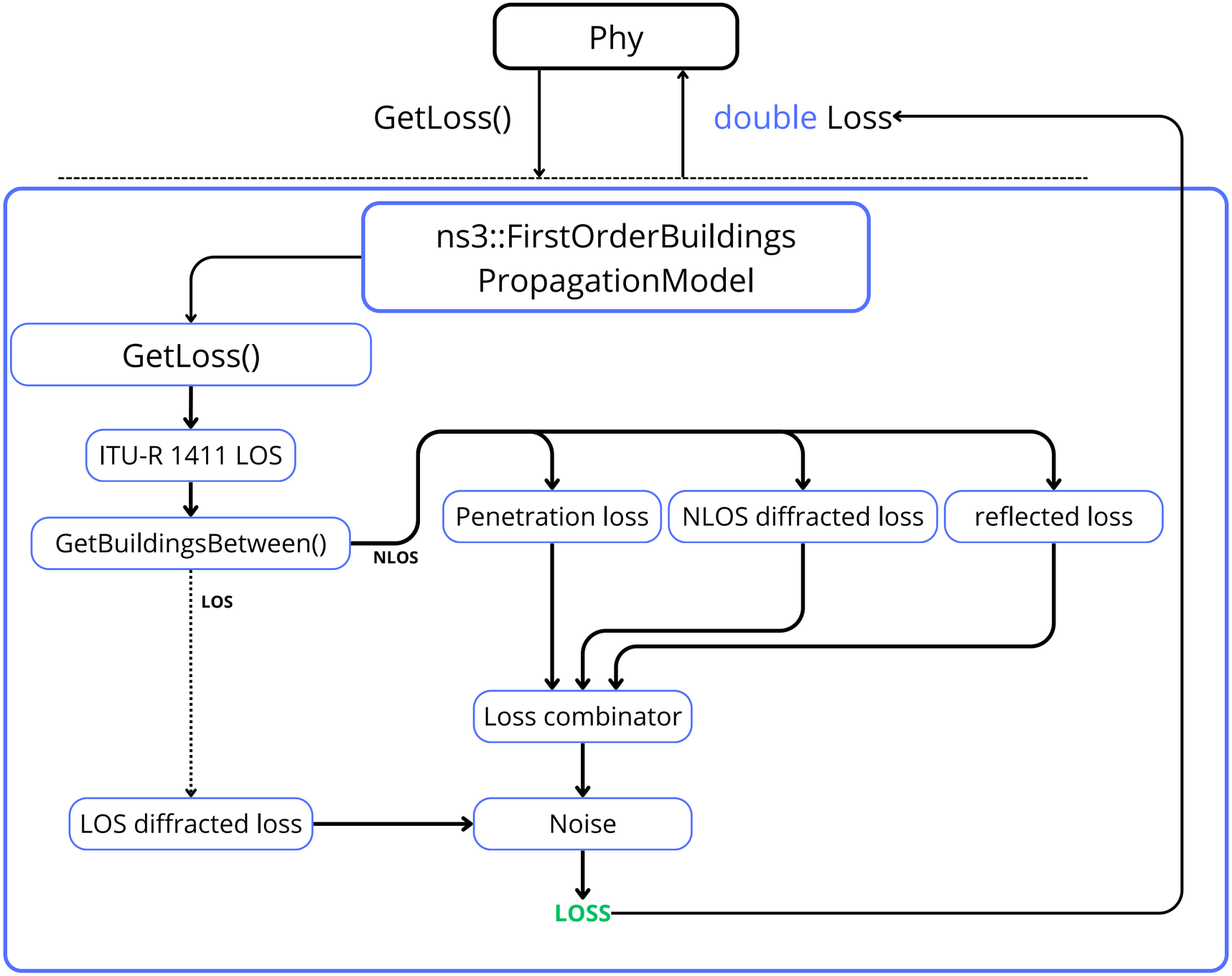
Reflection



Multipath link



1. NLOS detected dynamically
2. Number of building determined
3. Loss depend on diffracted link(s), reflected link(s) and building traversing link


Phy
GetLoss()
double Loss
ns3::FirstOrderBuildings
PropagationModel
GetLoss()
ITU-R 1411 LOS
GetBuildingsBetween()
NLOS
LOS
Penetration loss
NLOS diffracted loss
reflected loss
Loss combinator
LOS diffracted loss
Noise
LOSS

Penetration loss

Loss = sum(Loss of wall material x Number of walls)

Exemple :

Loss = -7dB x 2 + -5dB x 4

-7dB : Brick wall loss

2 : 2 walls

-5dB : Wood wall loss

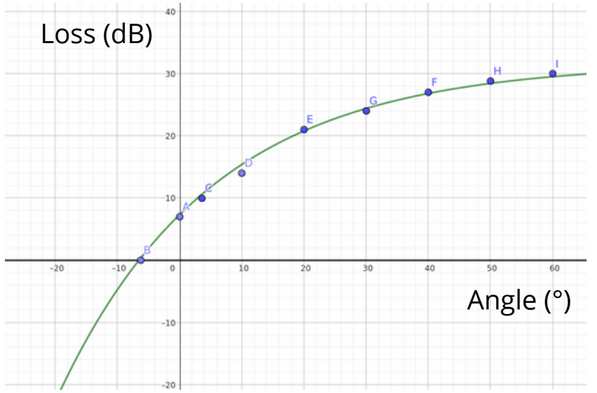
4 : 4 walls

diffracted loss → GetCorner() → calculateAngle()

Loss = f(angle)

a = 0.70
b = 24.9
c = 3.56
d = 31.7

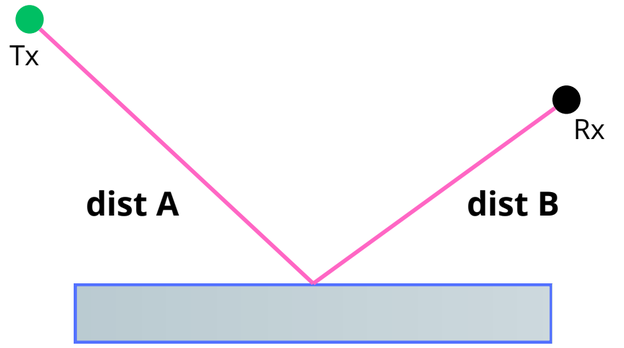
$$f(angle) = \frac{-a}{e^{\frac{angle}{b}} - c} + d$$

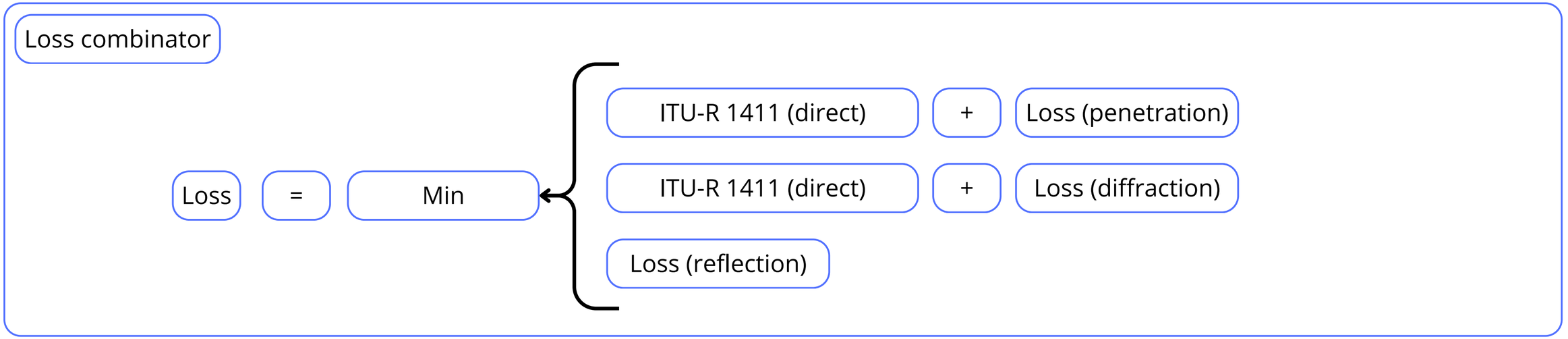


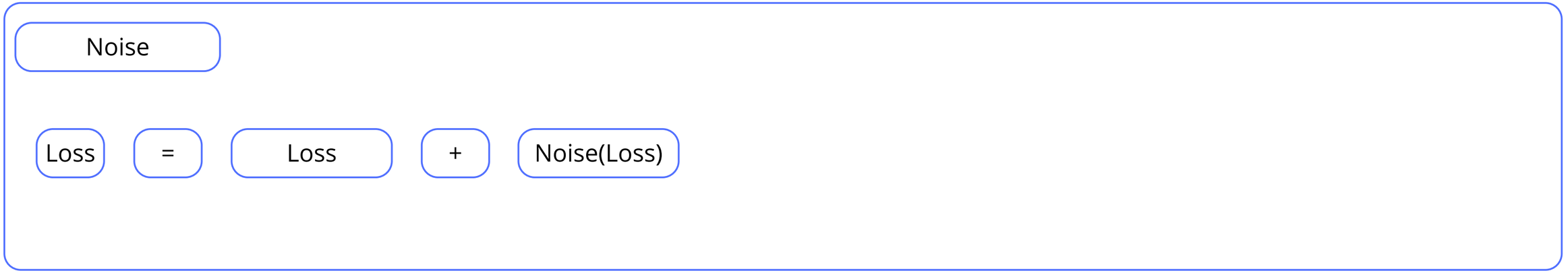
reflected loss (one bounce) → Getreflectionpoint(mob1, mob2)

P_{Tx} - ITU-R 1411 (distance A) x RAC - ITU-R 1411 (distance B)

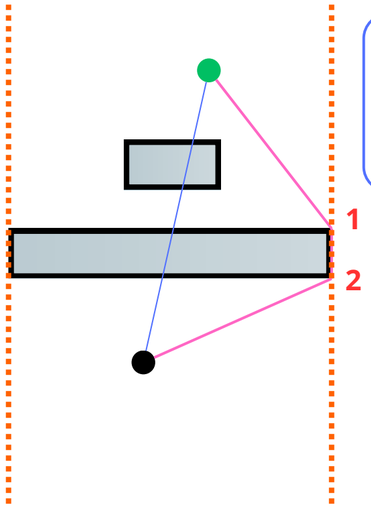
RAC : Reflection attenuation coef




Loss combinator
Loss
=
Min
ITU-R 1411 (direct)
+
Loss (penetration)
ITU-R 1411 (direct)
+
Loss (diffraction)
Loss (reflection)

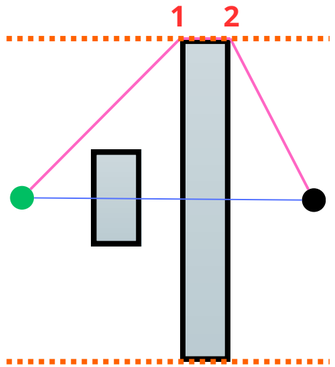

Noise
Loss
=
Loss
+
Noise(Loss)

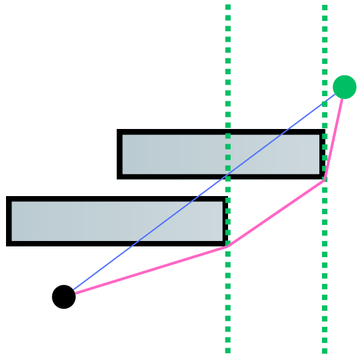
Diffracted loss (NLOS)



Nodes are both together in the same column/row respectivly to a given building. Automaticly, this positioning imply at least to diffraction phenomenon, the calcul is discarded. The limiting criterio here is :

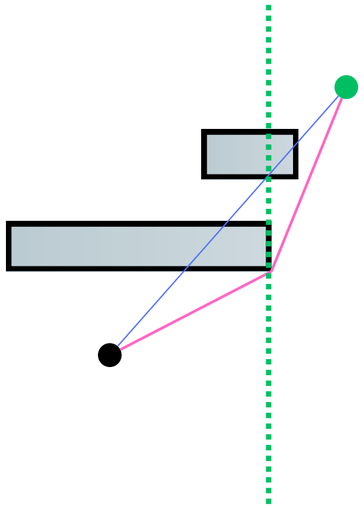
If the Tx/Rx couple is the same column/row of AT LEAST one (1) of the NLOS Buildings, there is AT LEAST two (2) diffraction.

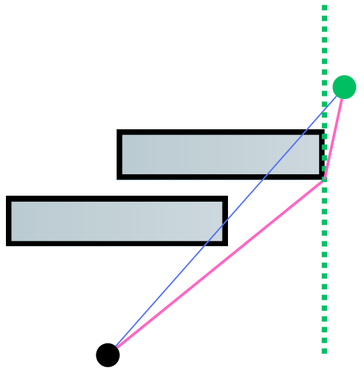




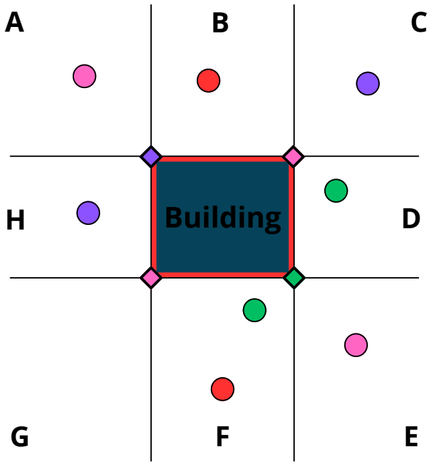
A more complexe case where the nodes are not in the same column/row but are placed in a maner where there is still at least 2 difffraction.

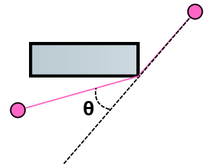
Signal as to do two or more diffraction





Signal as to do one diffraction

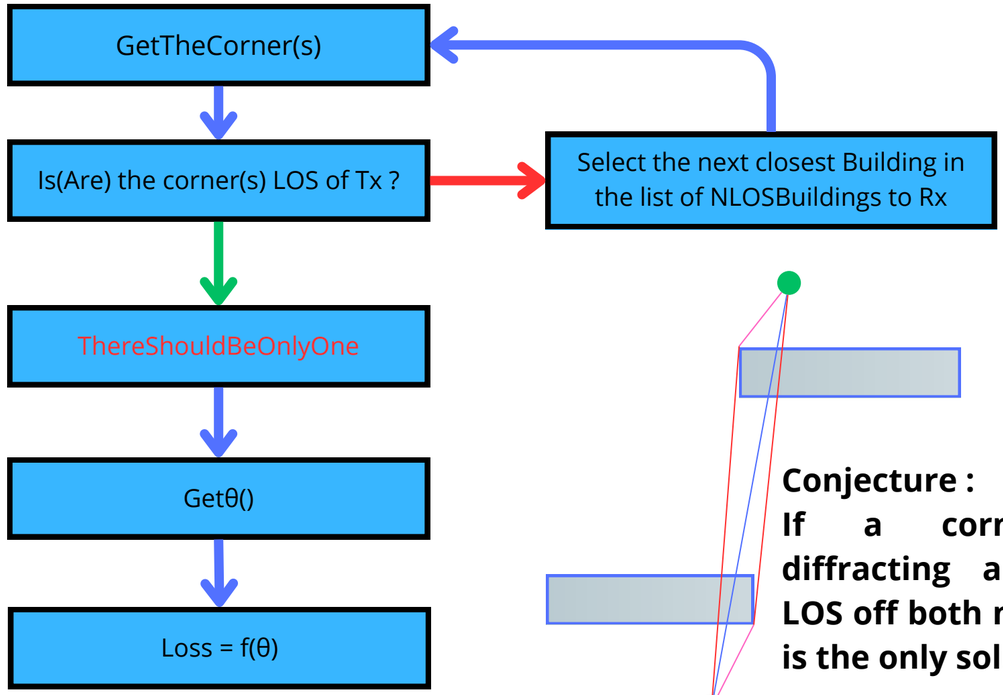




In **PINK** case two path are possible, the one chosen is the one where θ is minimal.

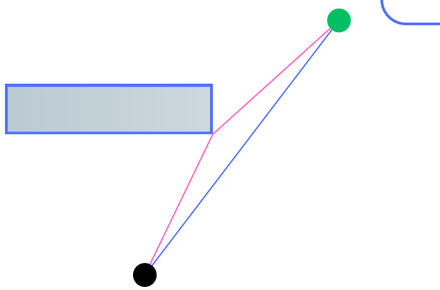
BG HB HC	x_{min} y_{max}	BE DB DA	x_{max} y_{max}	CG	x_{min} y_{max}	x_{max} y_{min}
HE FH FA	x_{min} y_{min}	DG FD FC	x_{max} y_{min}	AE	x_{min} y_{min}	x_{max} y_{max}
FB HD	ERR					

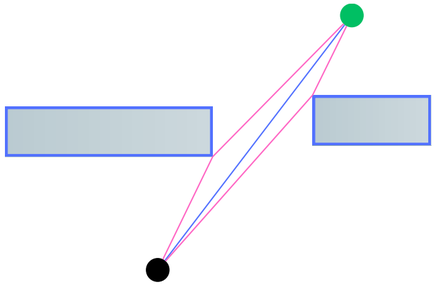
Process A

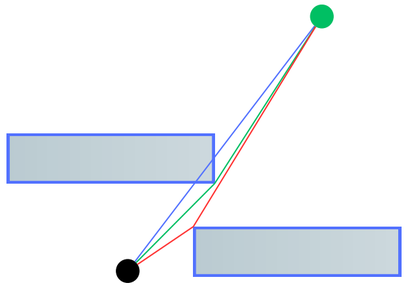


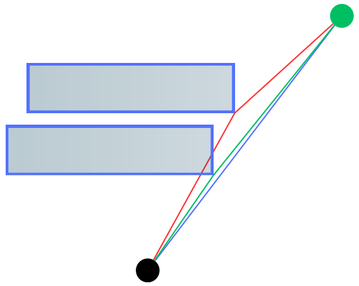
Conjecture :
If a corner is diffracting and has LOS off both nodes, it is the only solution

Diffracted loss (LOS)

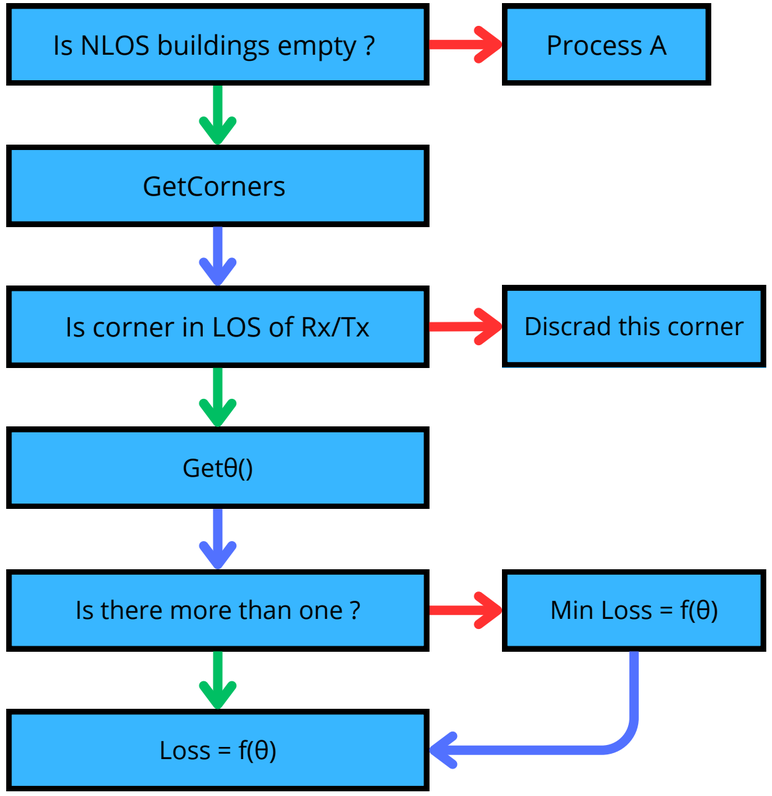


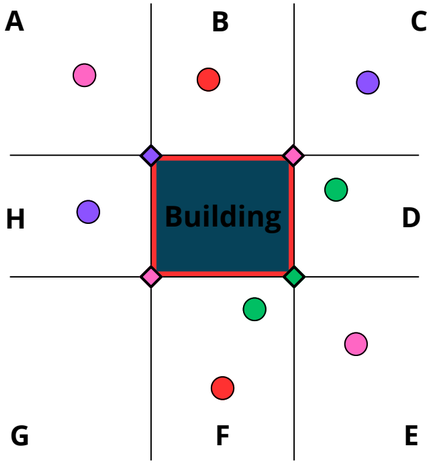


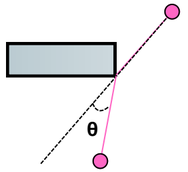




Process B







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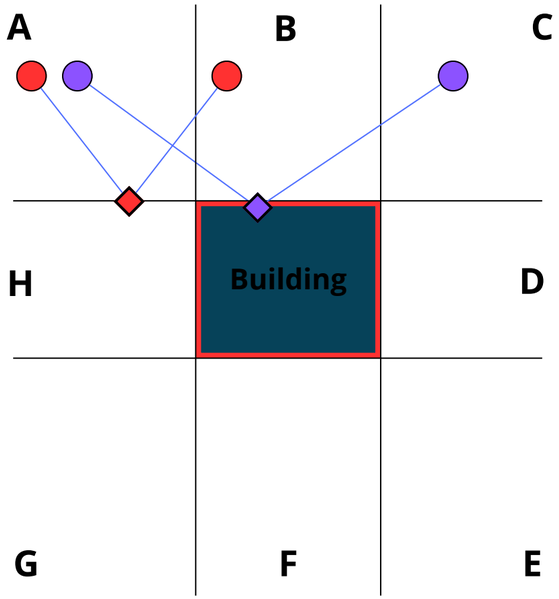
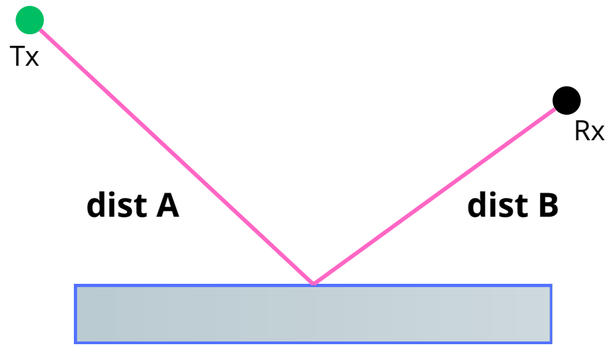
BG HB HC	x_{min} y_{max}	BE DB DA	x_{max} y_{max}	CG	x_{min} y_{max}	x_{max} y_{min}
HE FH FA	x_{min} y_{min}	DG FD FC	x_{max} y_{min}	AE	x_{min} y_{min}	x_{max} y_{max}
FB HD	ERR					

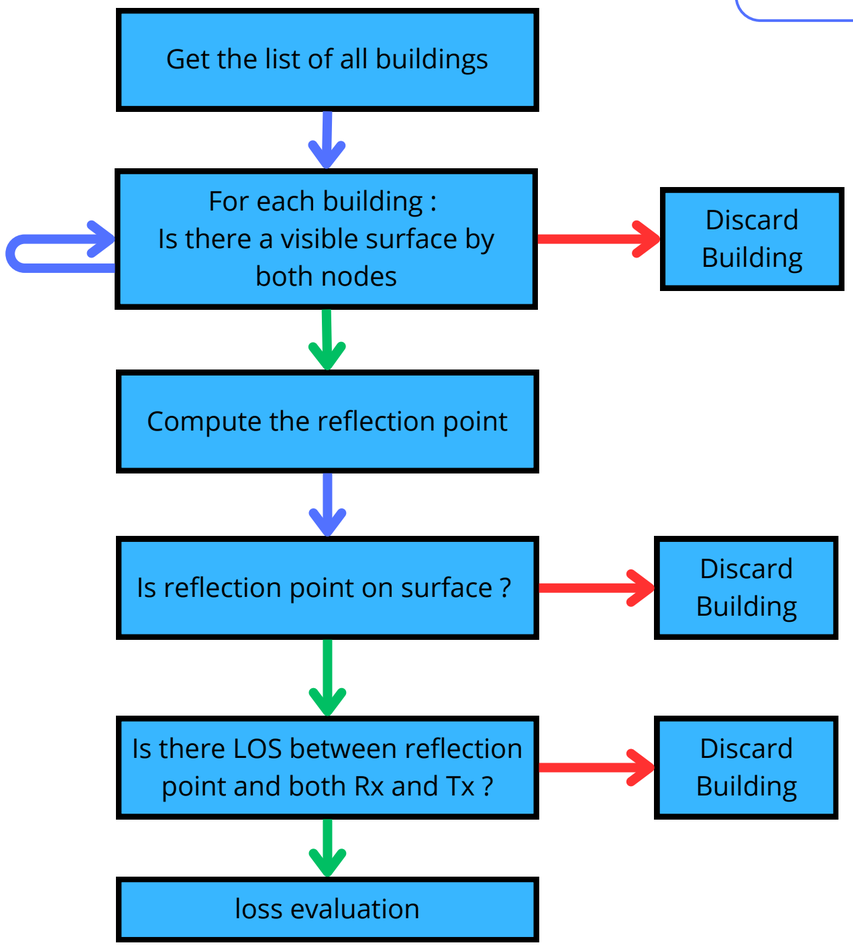
Reflected loss



FF	GF FE EG	x_{min}	BB	AB BC AC	x_{max}
HH	AH HG GA	y_{min}	DD	CD DE EC	y_{max}
AA	x_{min} y_{max}		CC	x_{max} y_{max}	
GG	x_{min} y_{min}		EE	x_{max} y_{min}	

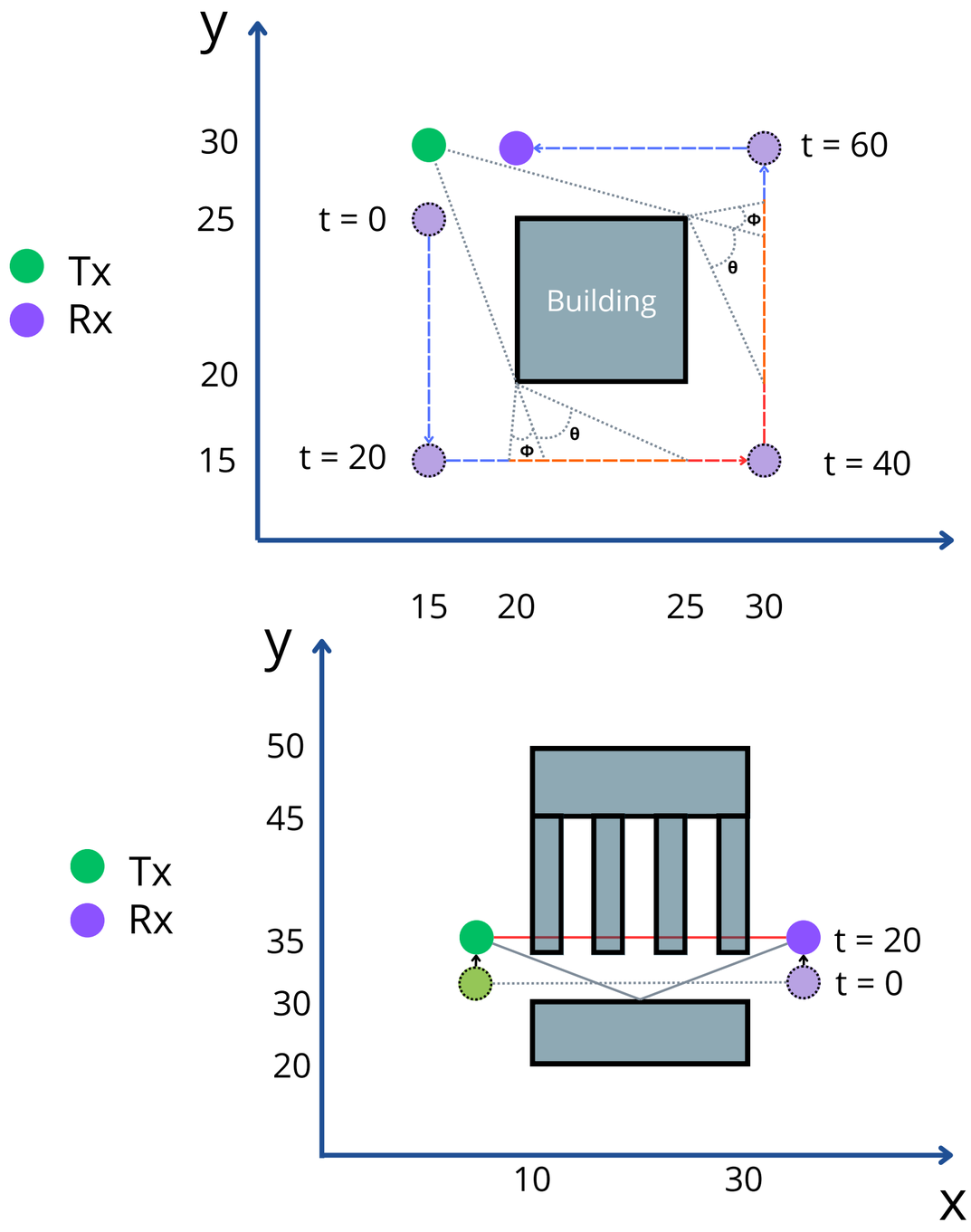


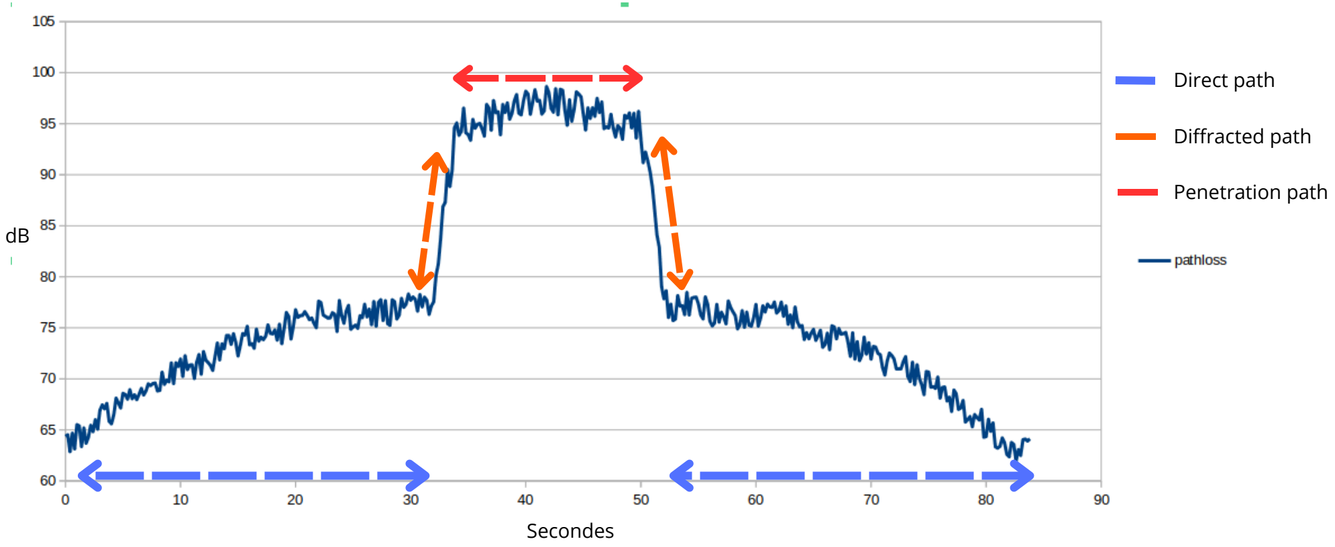
Process C



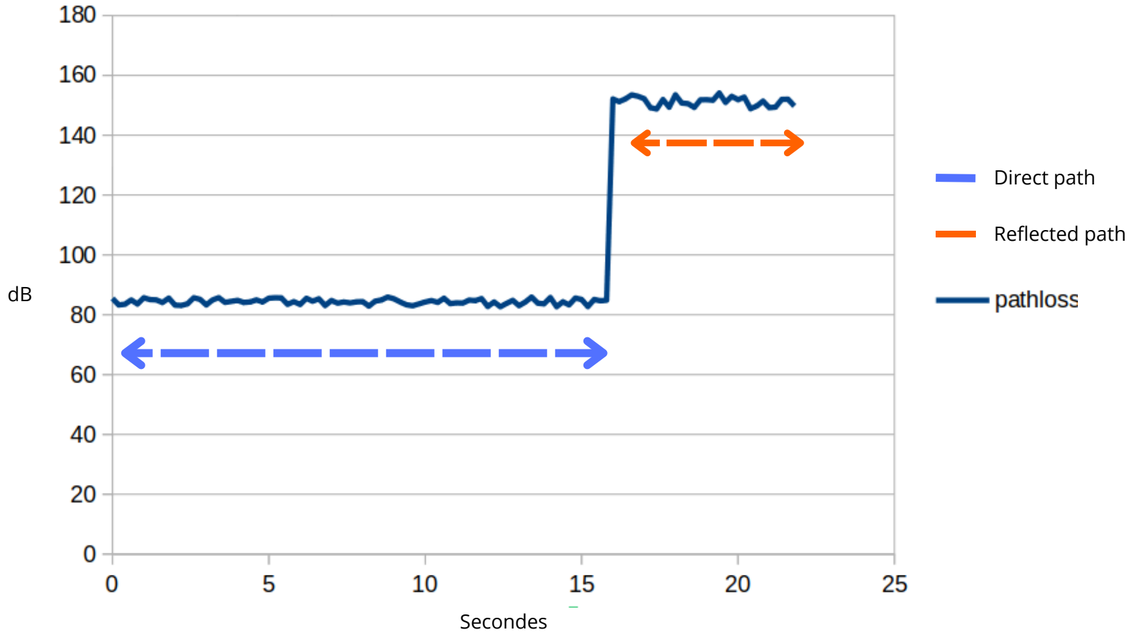
P_{Tx} - ITU-R 1411 (distance A) x RAC - ITU-R 1411 (distance B)

RAC : Reflection attenuation coef


y
30
25
20
15
t = 0
t = 60
t = 20
t = 40
Building
Φ
θ
θ
Φ
15
20
25
30
Tx
Rx


dB
105
100
95
90
85
80
75
70
65
60
0
10
20
30
40
50
60
70
80
90
Secondes
Direct path
Diffracted path
Penetration path
pathloss

y
50
45
35
30
20
t = 20
t = 0
10
30
x
Tx
Rx


dB
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
Secondes
Direct path
Reflected path
pathloss