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ns-3
ICNS3 2025

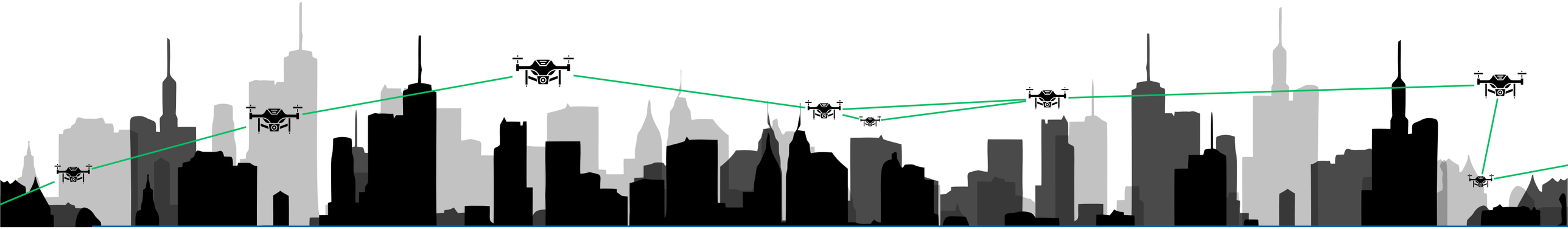
Buildings Aware Path Loss Modeling in ns-3

Hugo Le Dirach*✦
Ph.D. student at ONERA
Supervised by Ph.D. Boyer* and Ph.D. Lochin✦

* DTIS, ONERA, Université de Toulouse
✦ Fédération ENAC ISAE-SUPAERO ONERA, Université de Toulouse

1. The Problem

What are the network performances under different routing algorithms in complex urban environments ?



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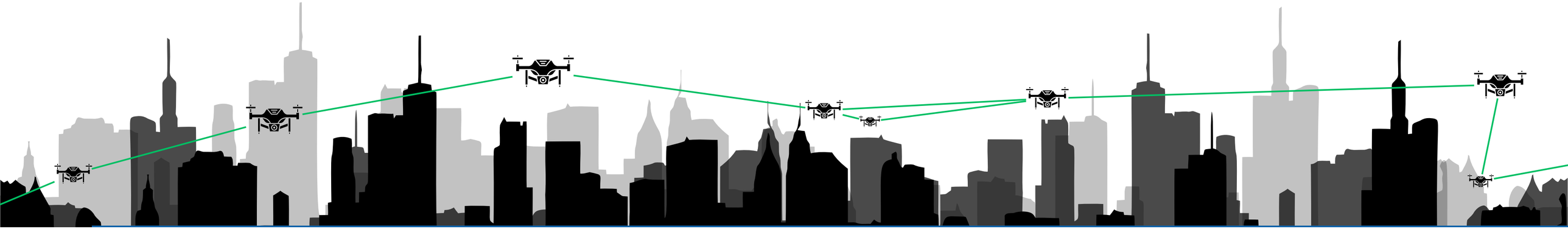

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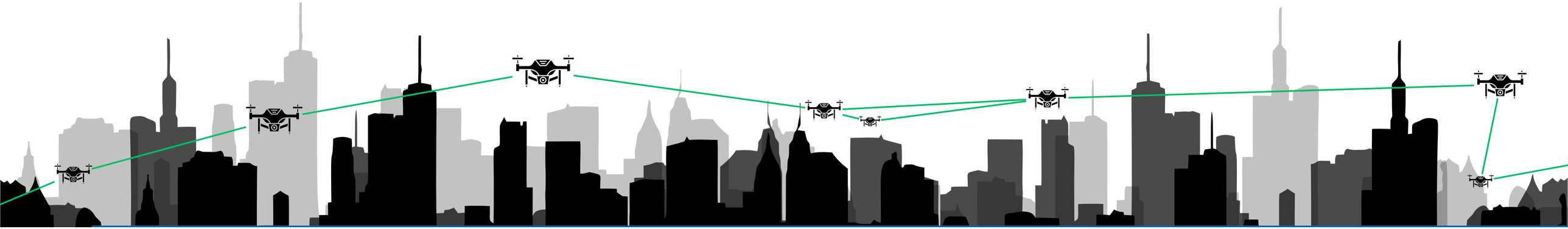

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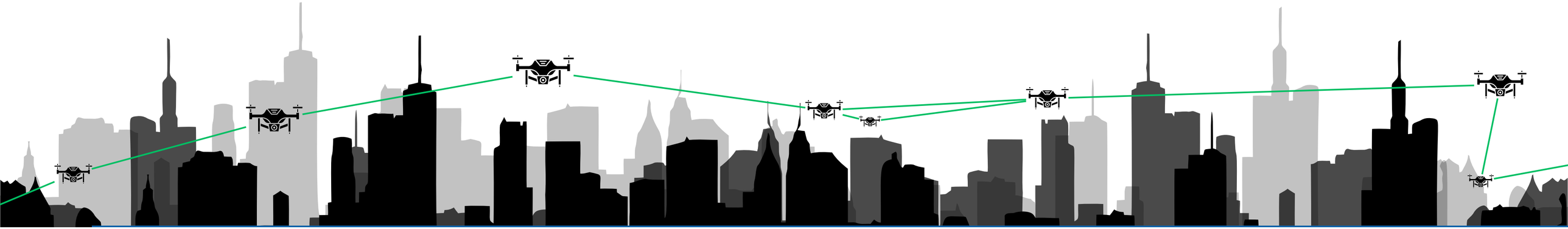

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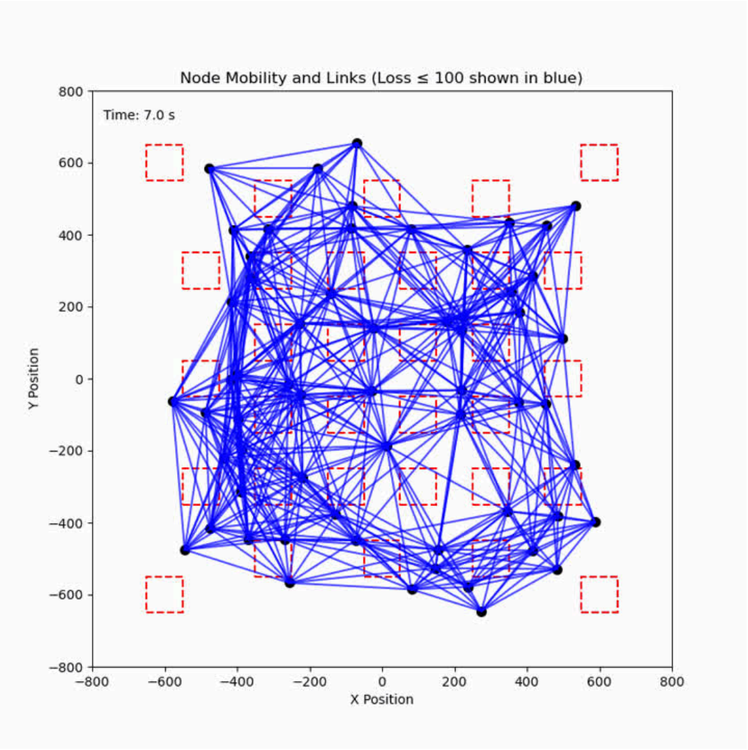
What ns-3 provides



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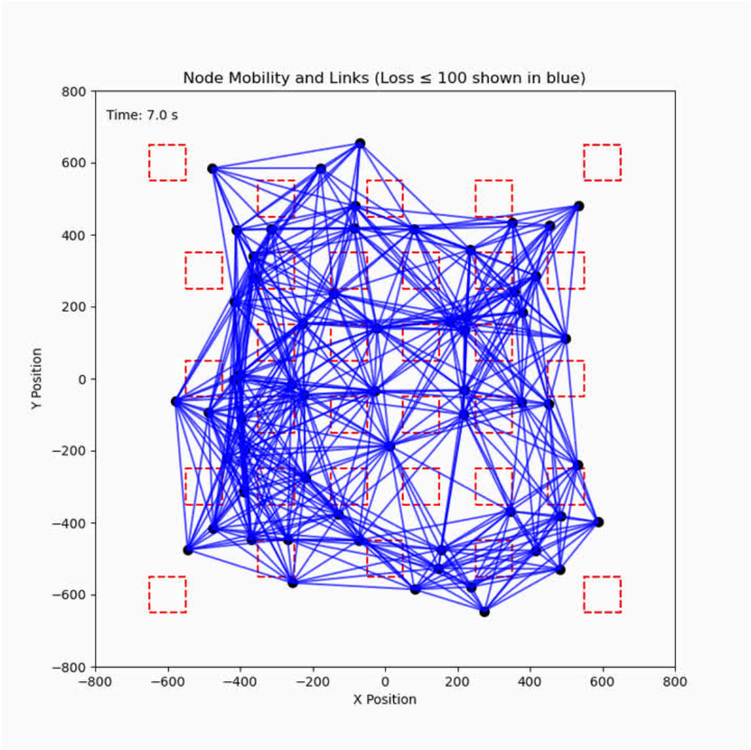
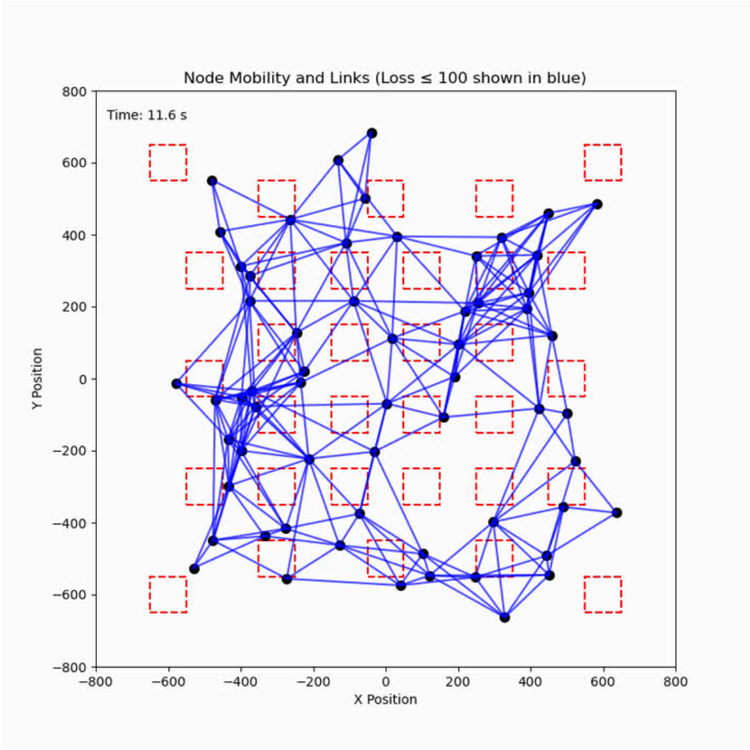
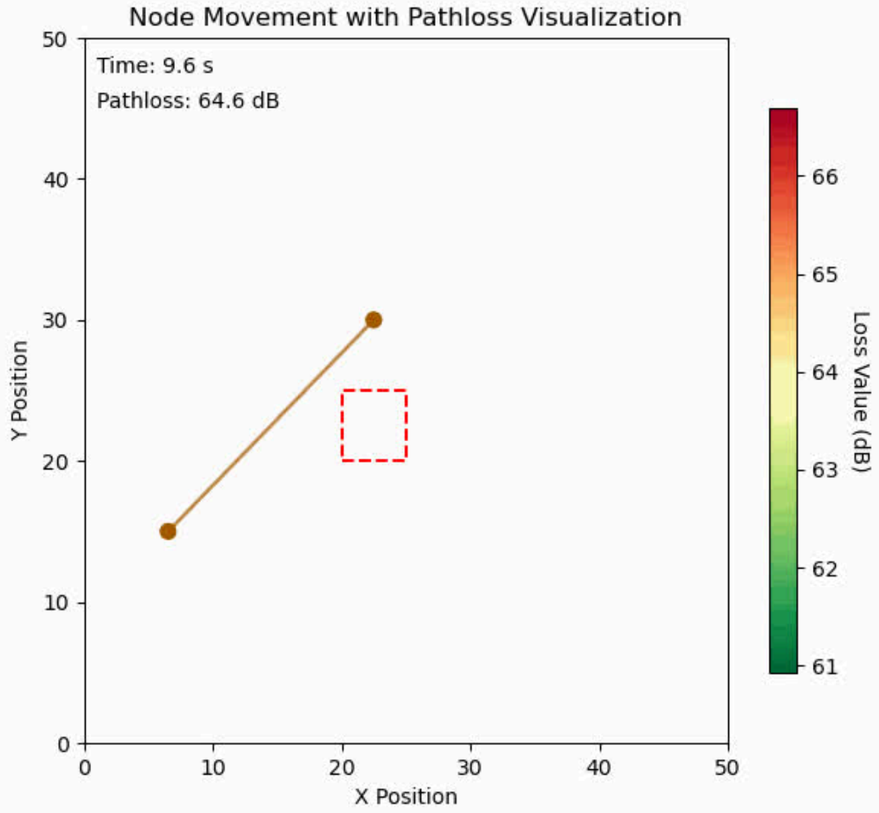


What I need

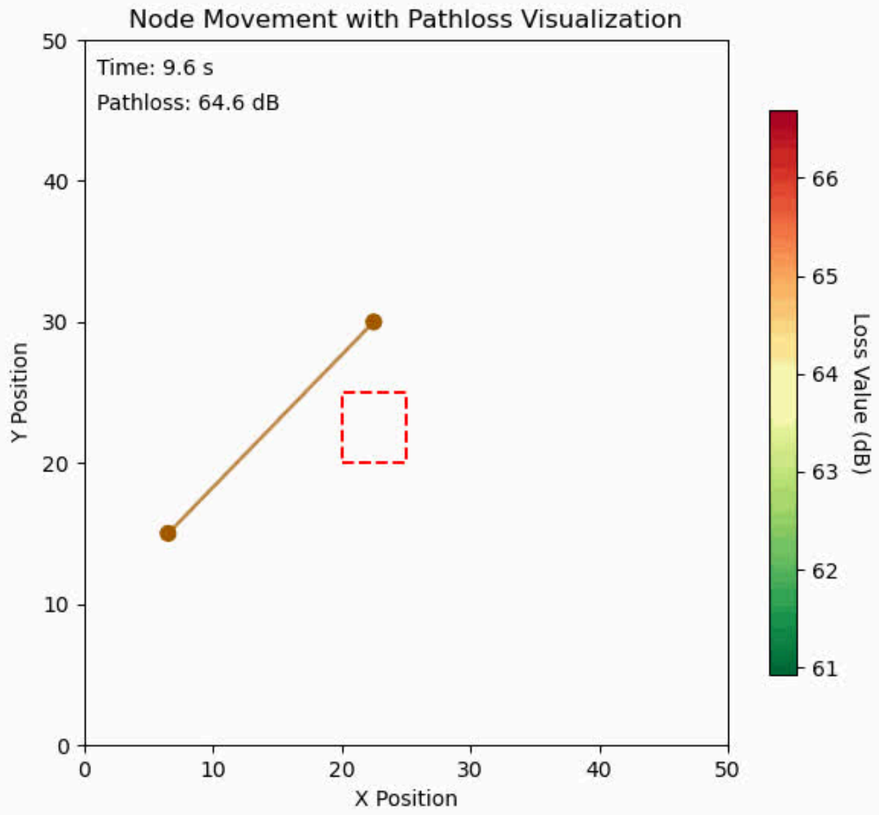


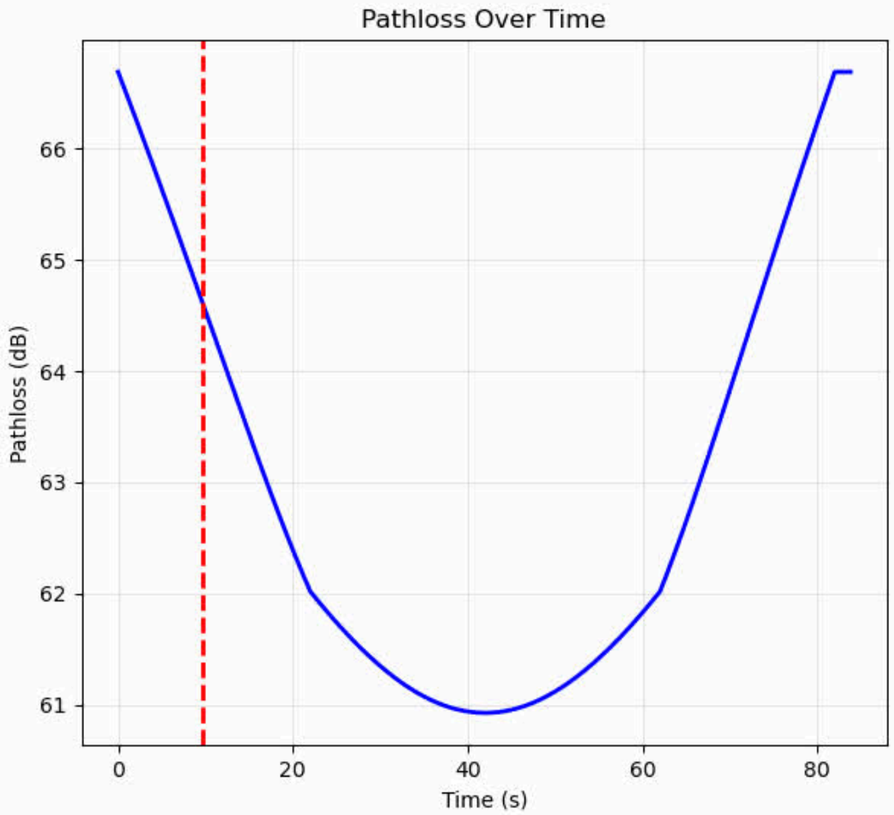
Taking a smaller scales as a case study



1. The Problem

we see that the building is being ignored





Summary

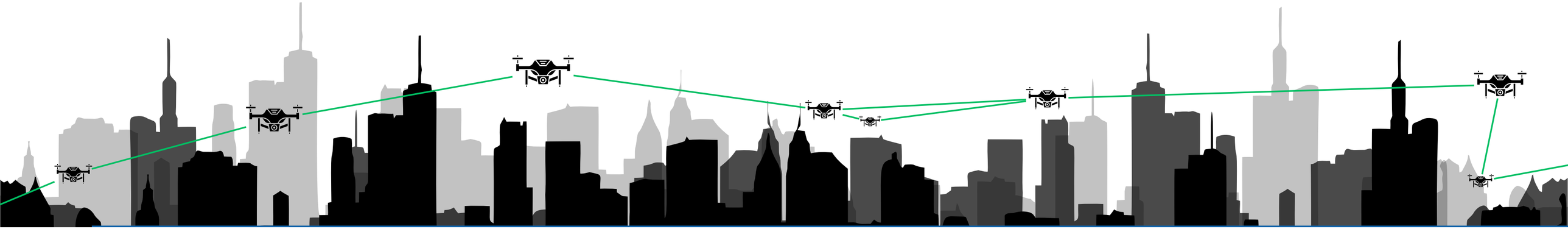
I. The problem

II. Other paper ignore the loss model, a crucial component

III. Taking buildings into account for the signal propagation

IV. Implementation and results

V. Outlook



2. Other paper ignore the loss model, a crucial component

71 %

of 35 papers on routing algorithm performance evaluations are done with

ns-3

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ns-3

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0 %

Have common set up

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n s - 3

0 %

Have common set up

2. Other paper ignore the loss model, a crucial component

38 %

Explicitly give the loss model used

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Use models that take obstacles into account

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Taking buildings into account for the signal propagation

3. Taking buildings into account for the signal propagation

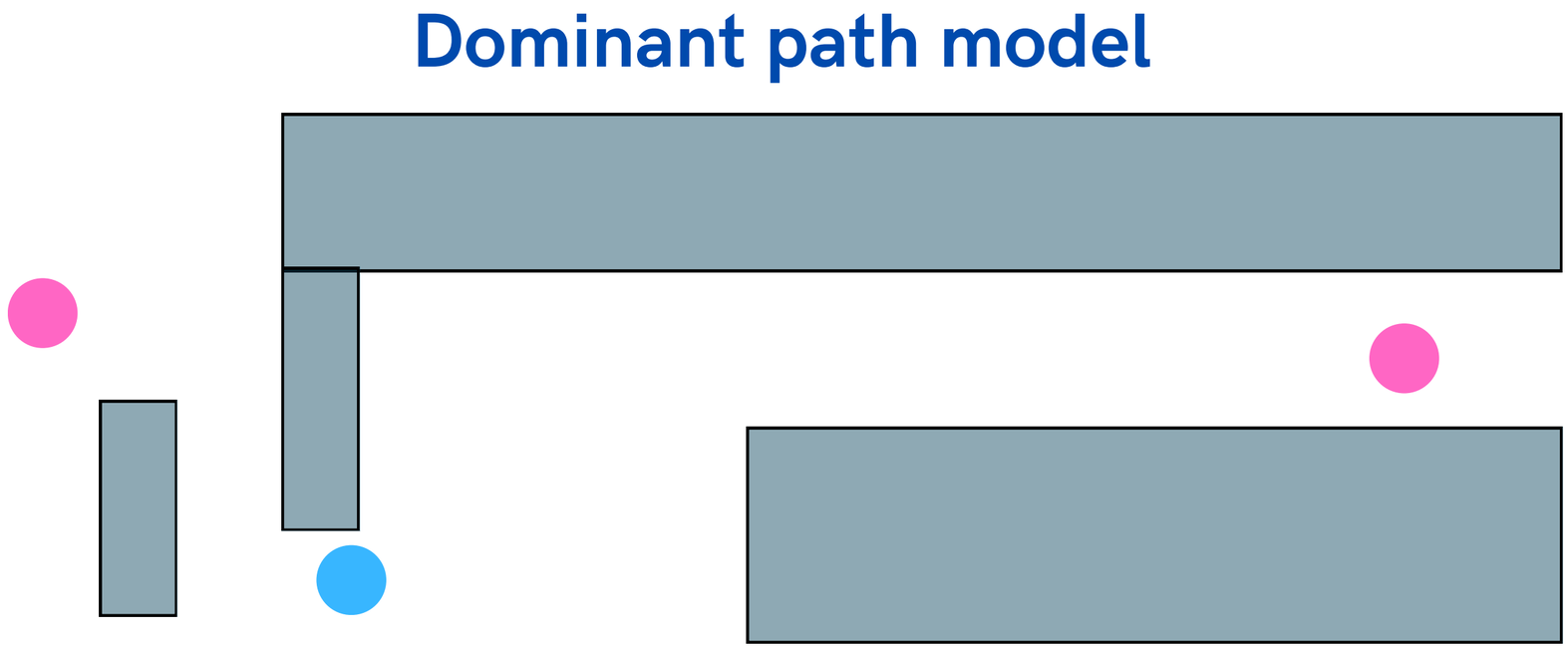
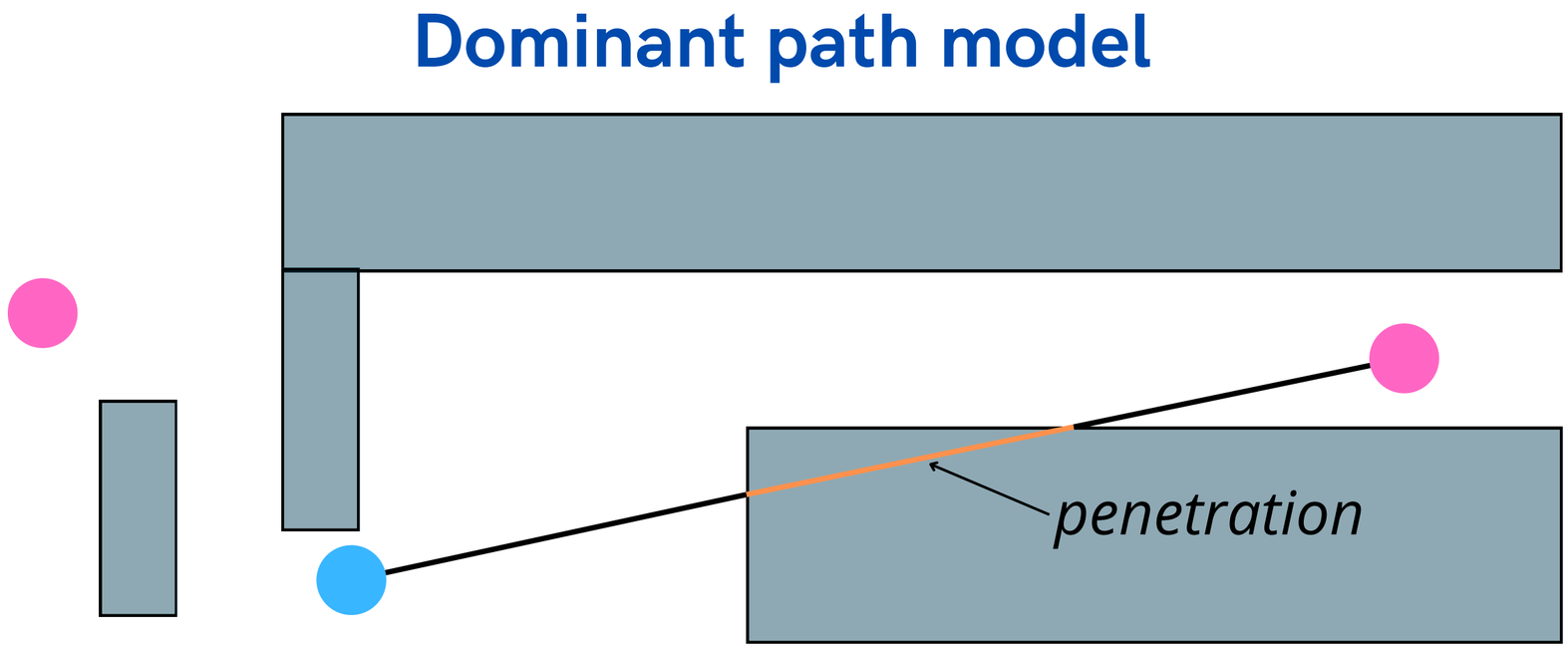


Figure 3 : The dominant path method where the signal, considered as a ray, interacts with the object in the medium (penetration, diffraction, reflection).

3. Taking buildings into account for the signal propagation



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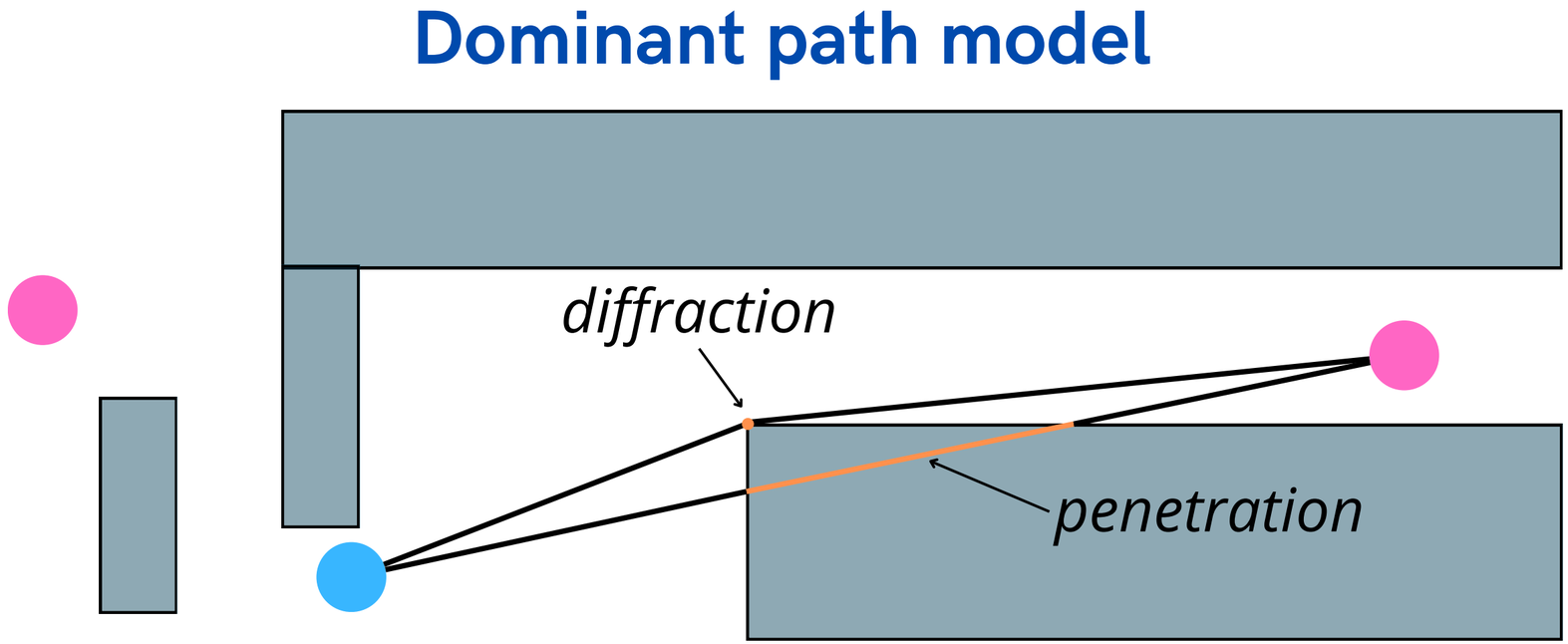

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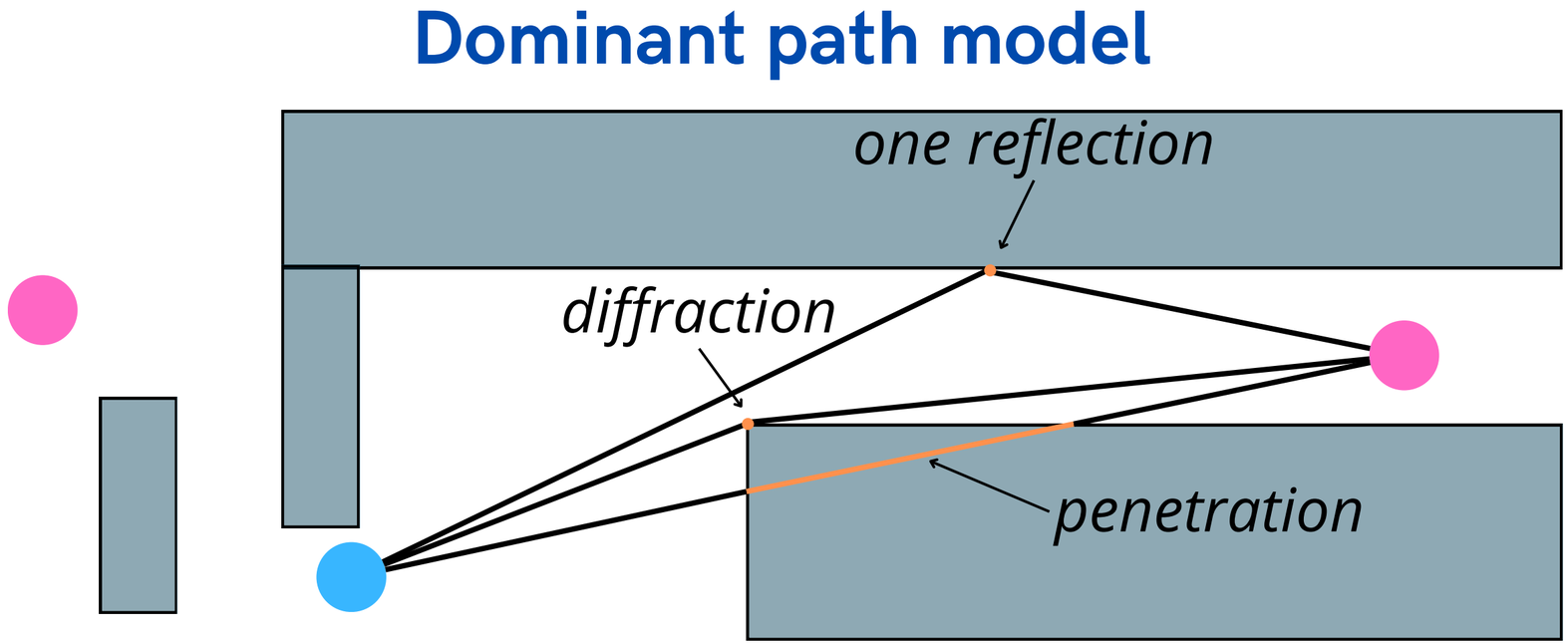

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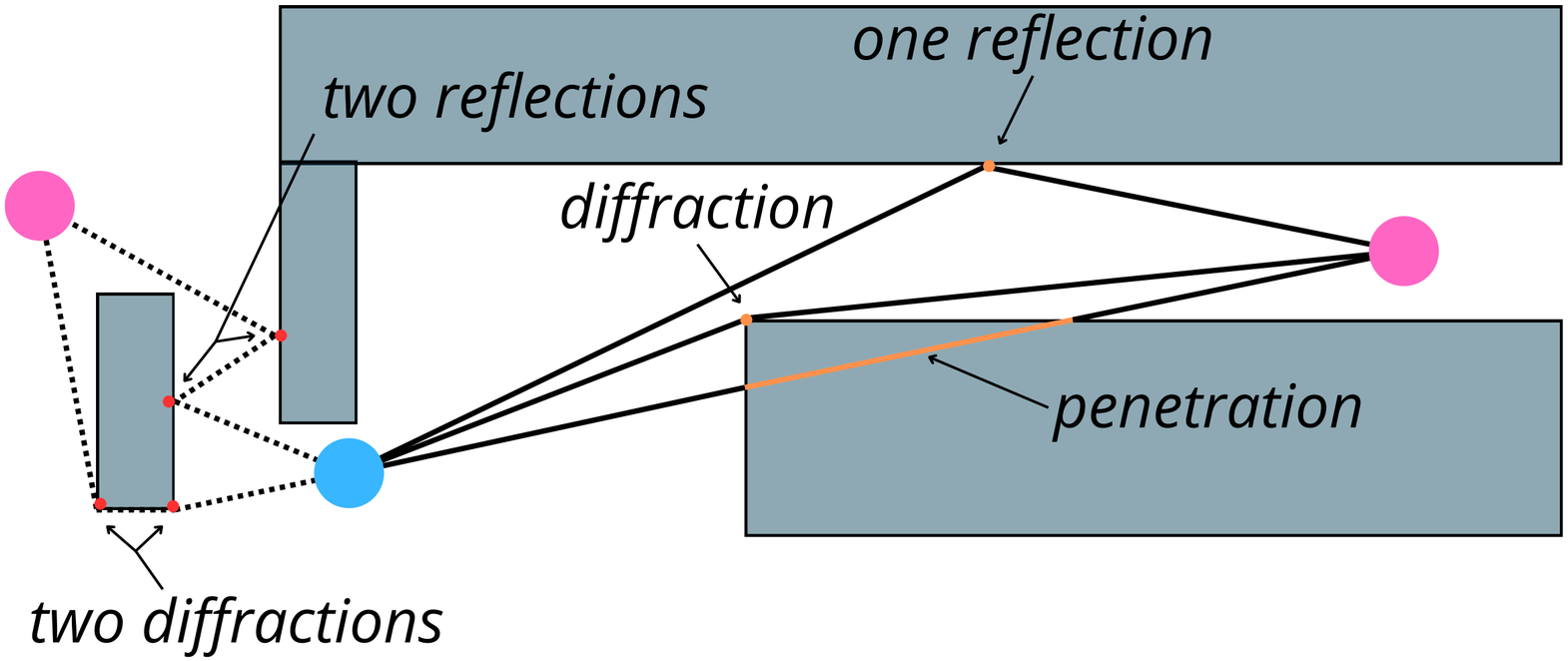
3. Taking buildings into account for the signal propagation

Dominant path model



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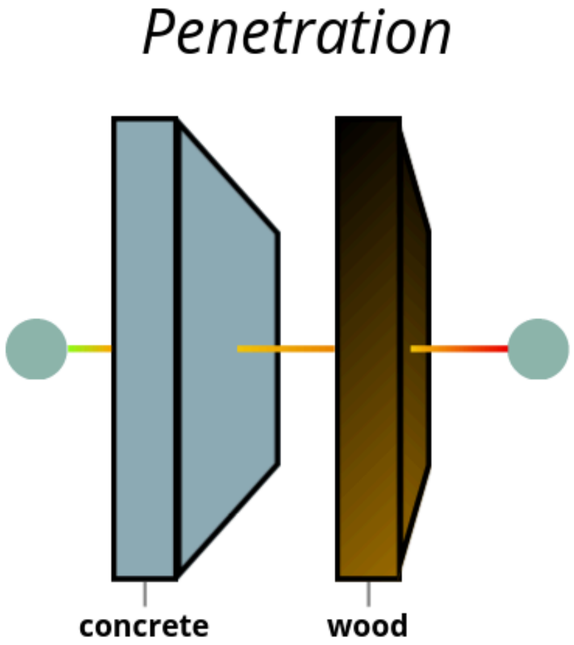

Figure 4 : Visual representation of signal penetration, diffraction and reflection on objects.

3. Taking buildings into account for the signal propagation

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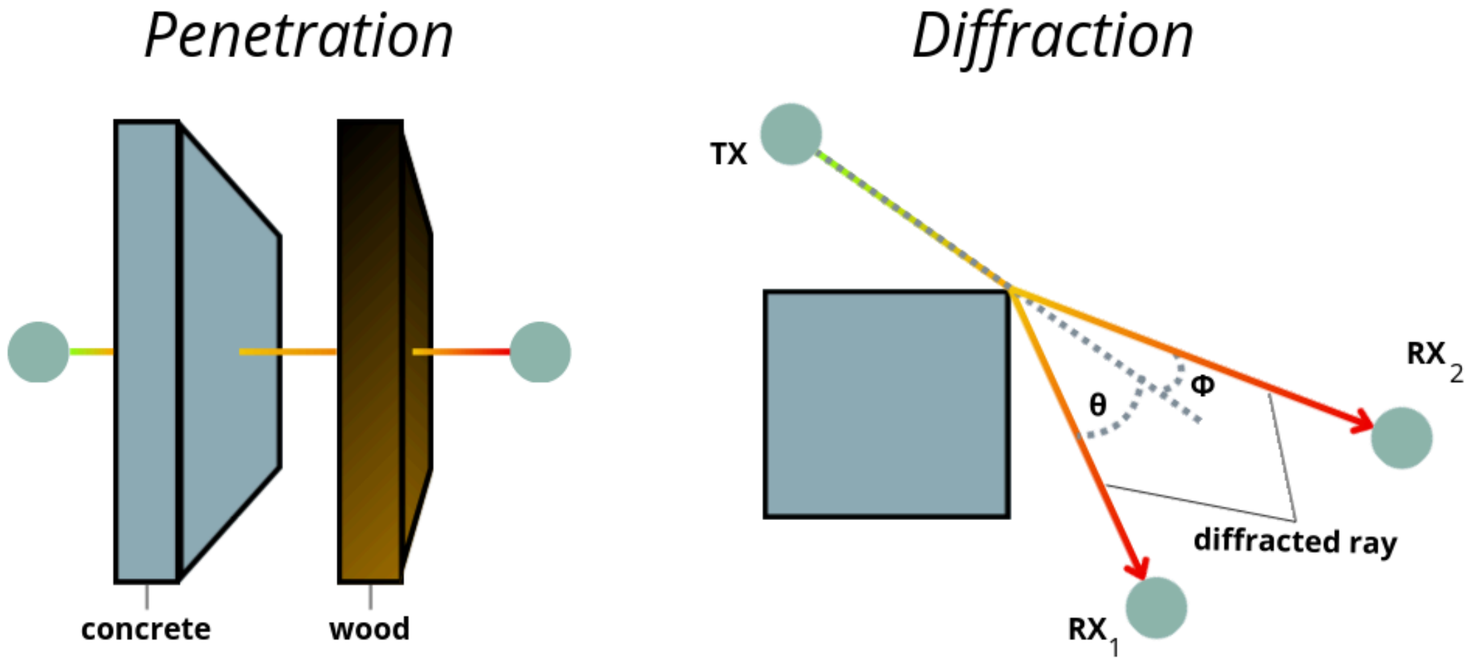

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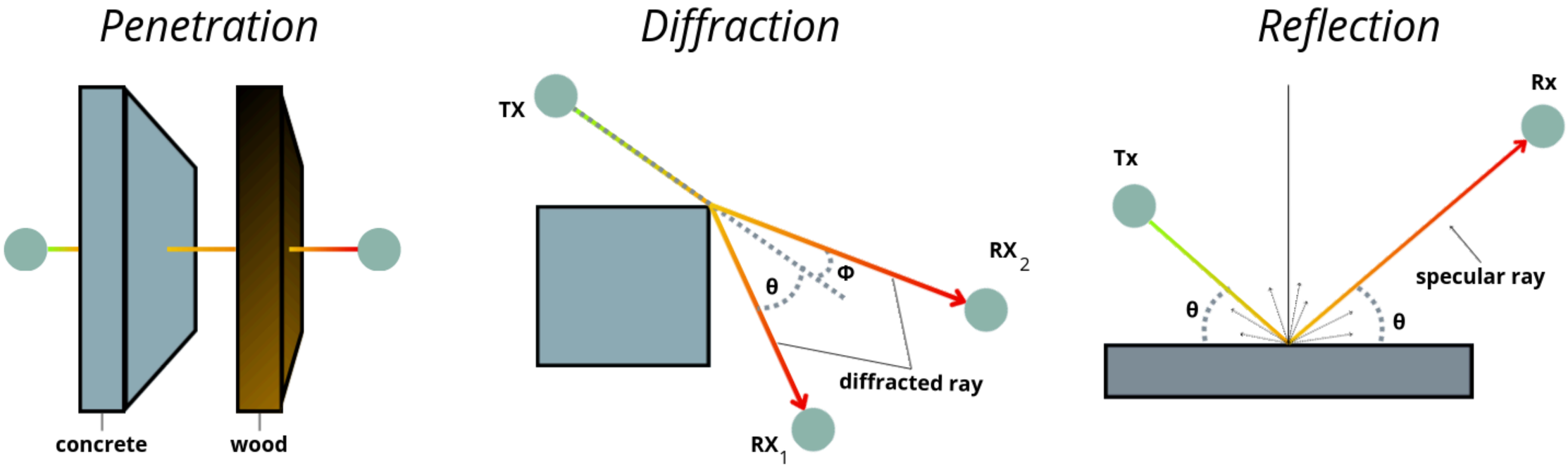

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Implementation and results

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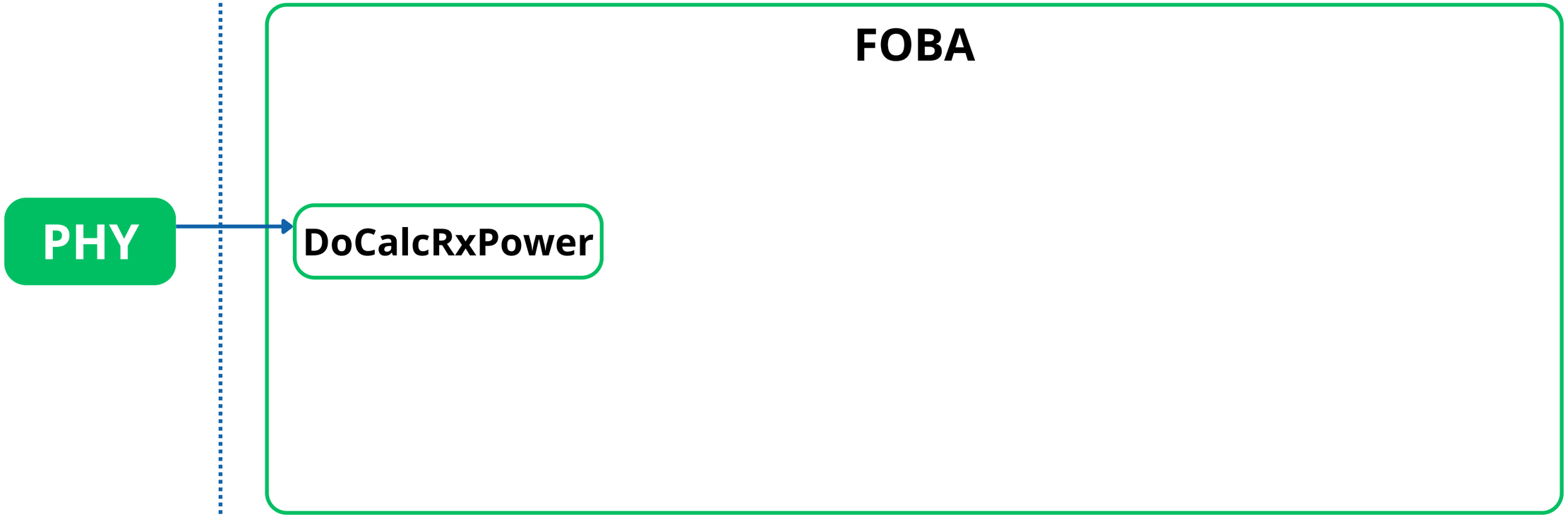

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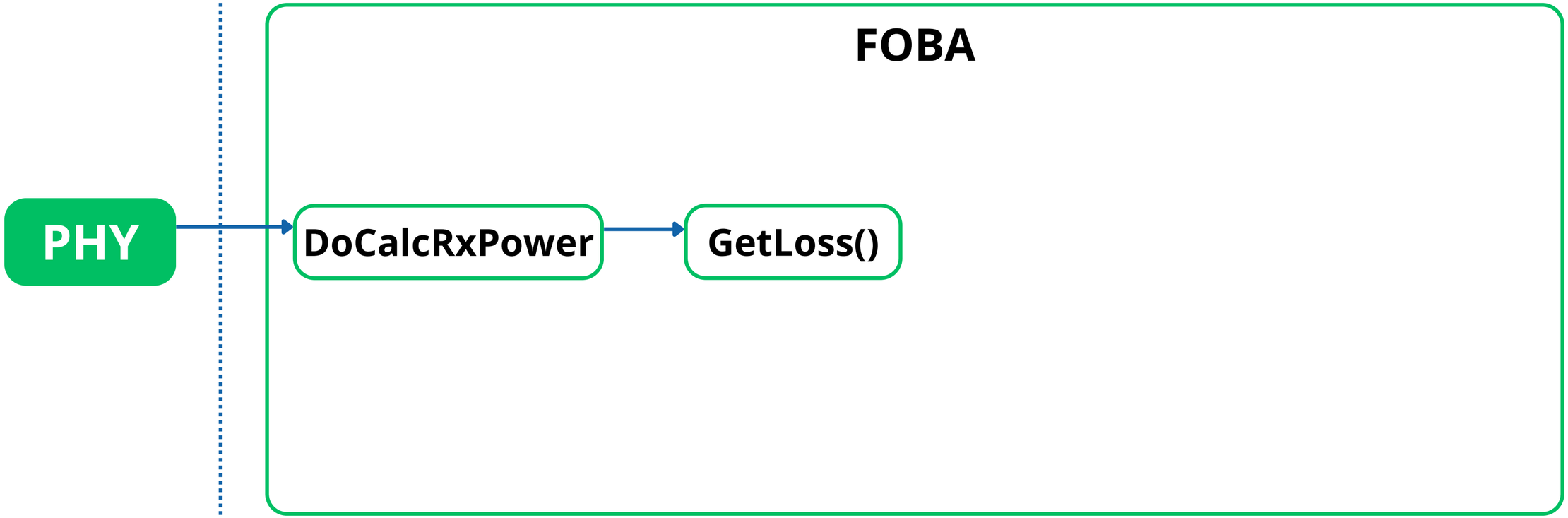

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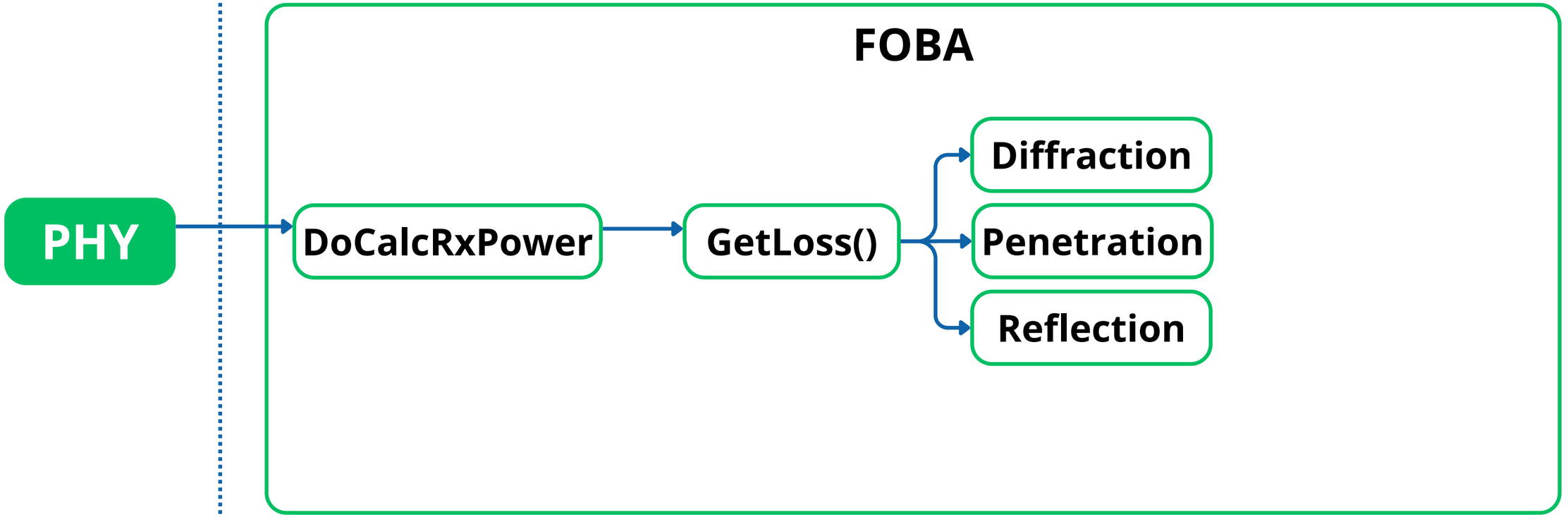

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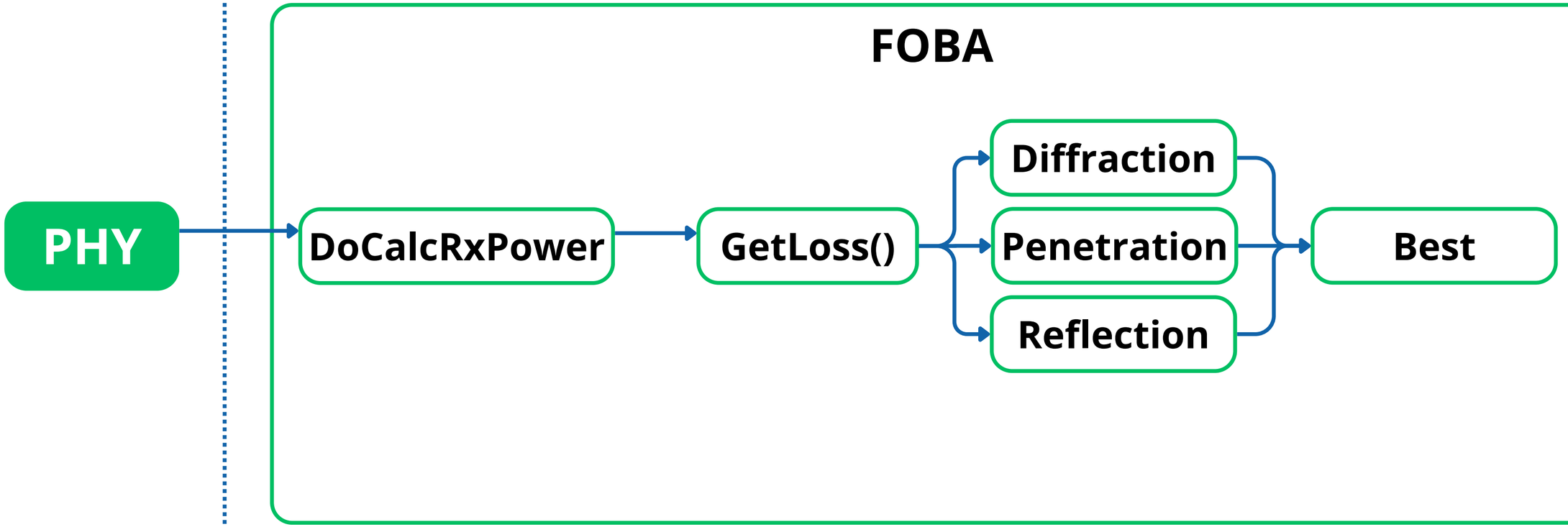

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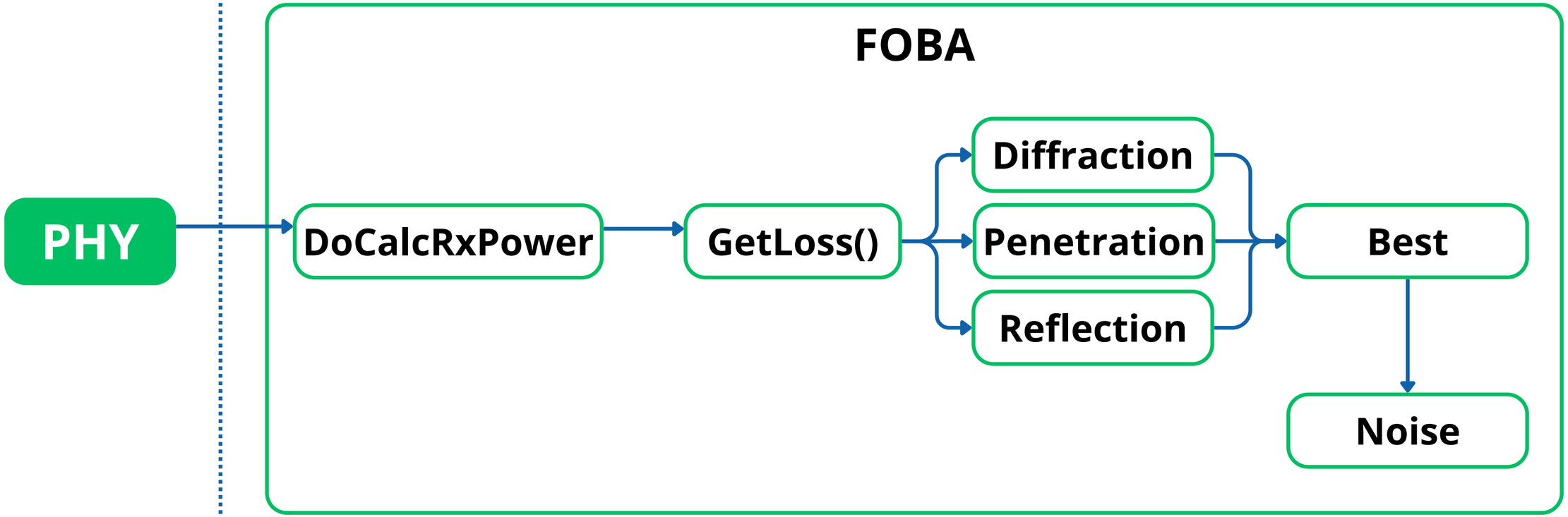

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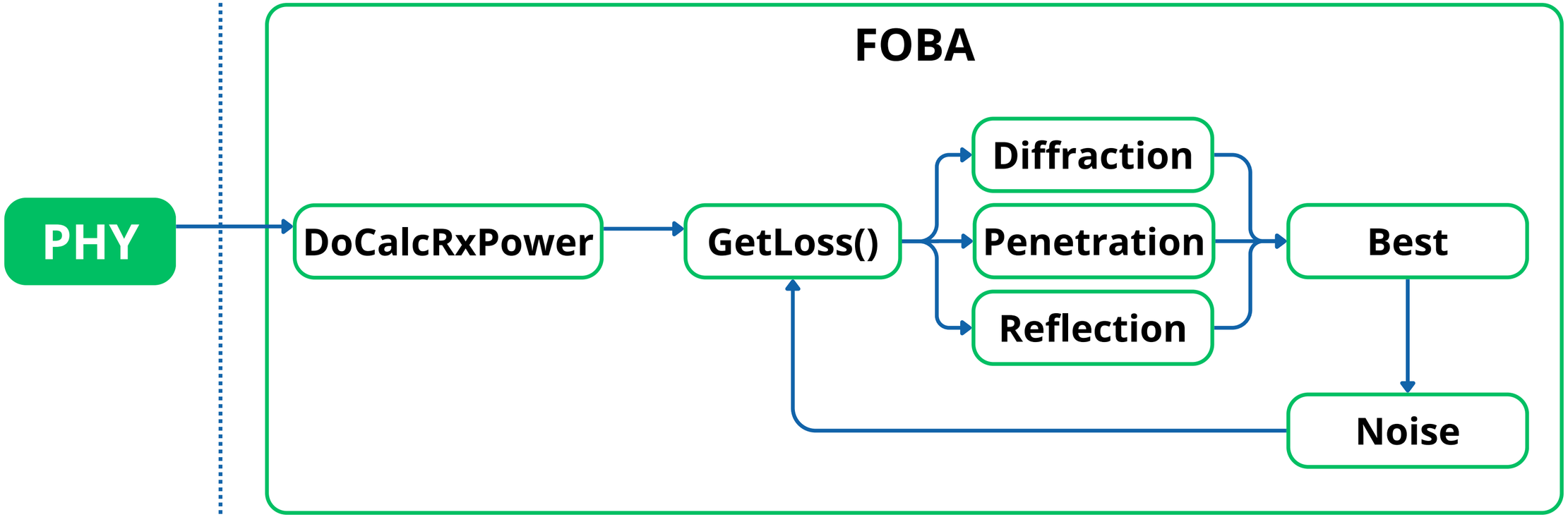

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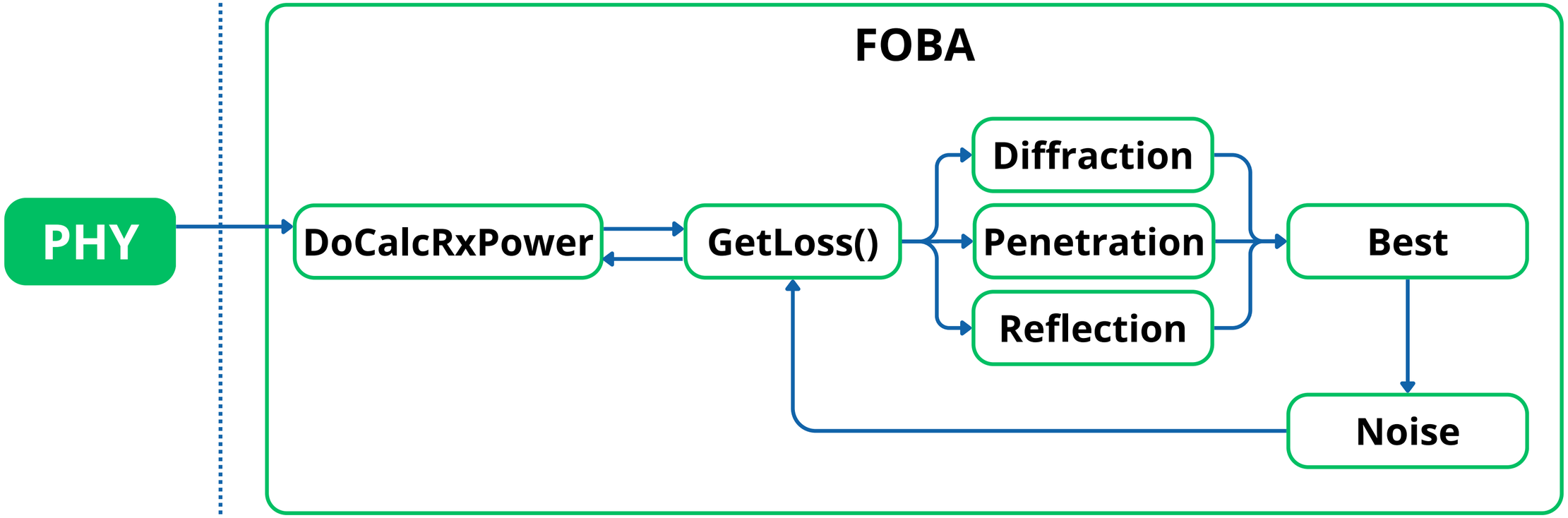

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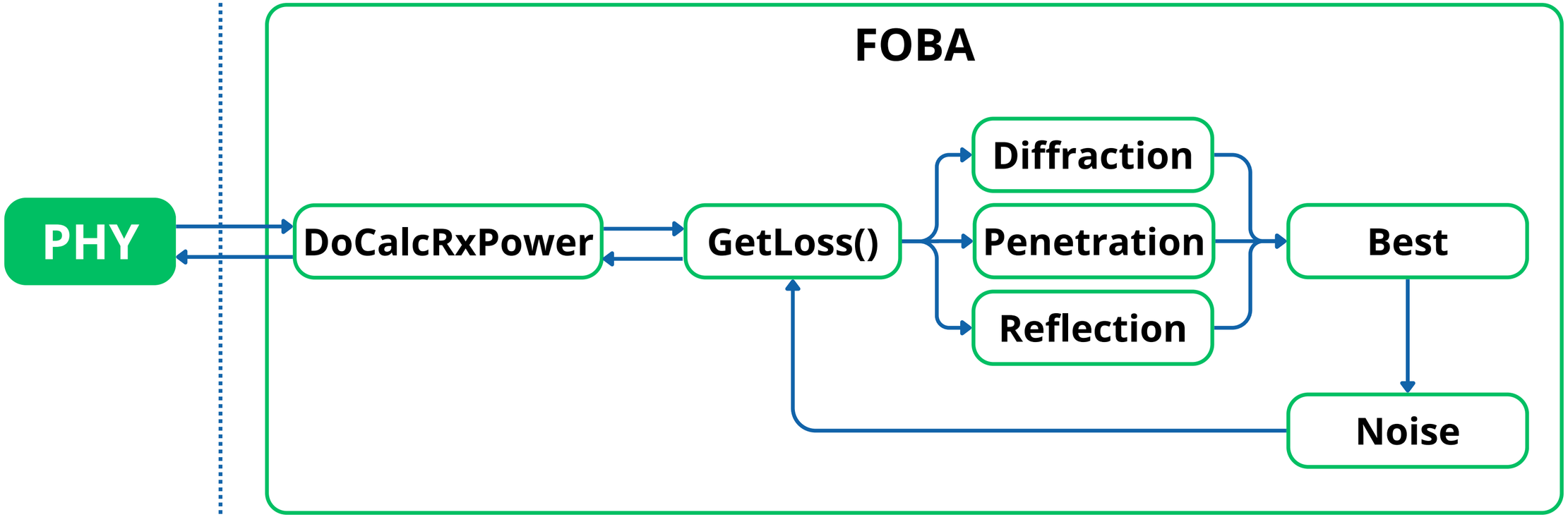
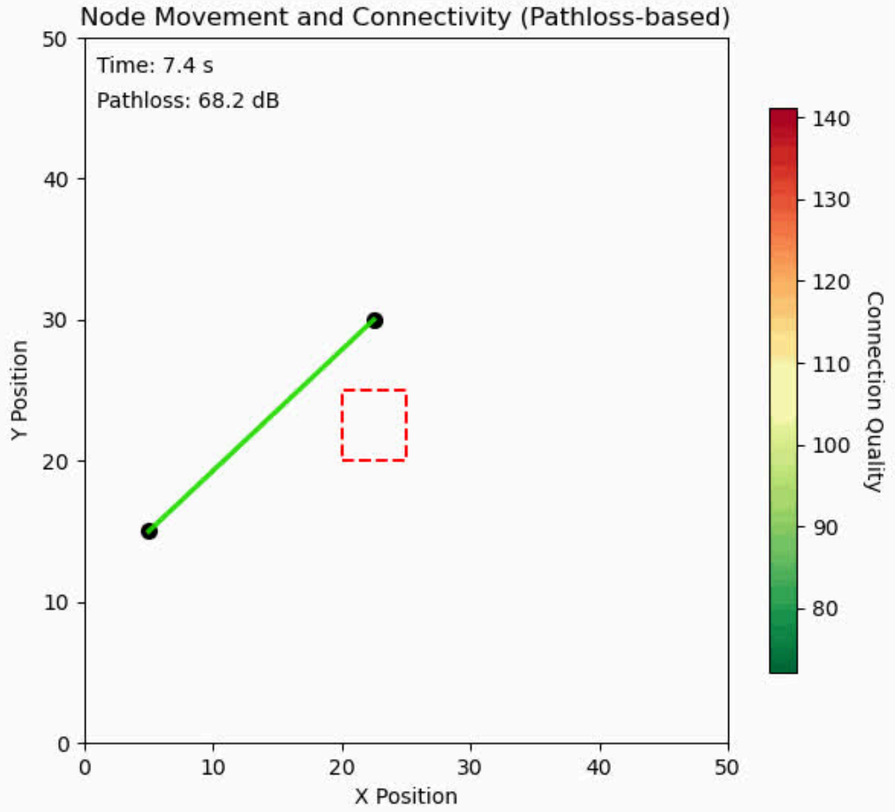
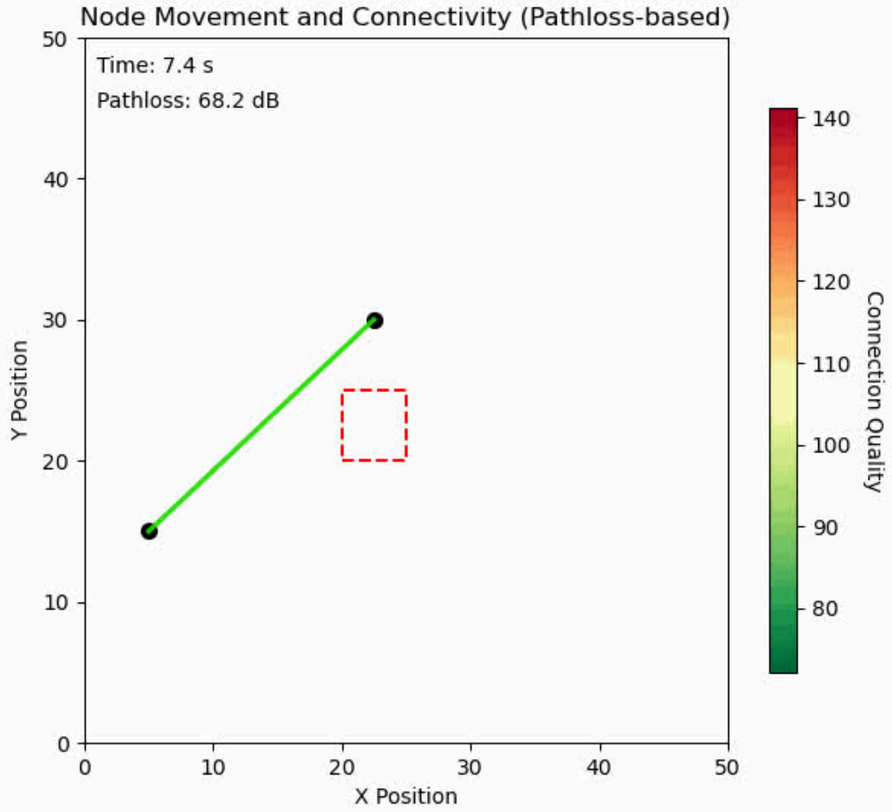


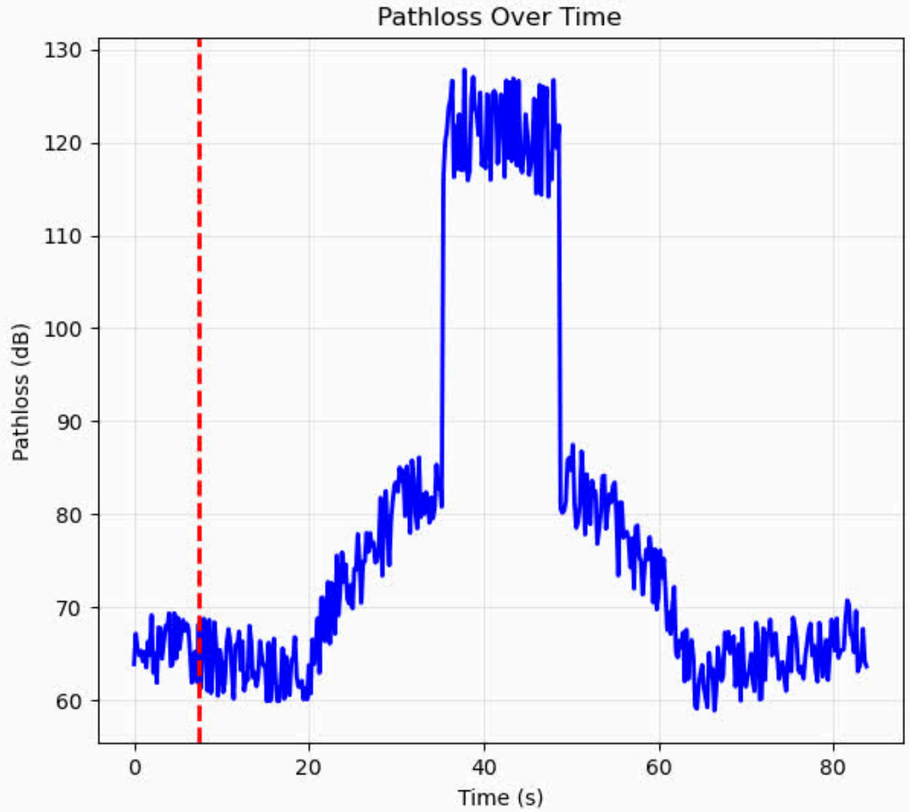
Comming back to the first scenario



4. Implementation and results

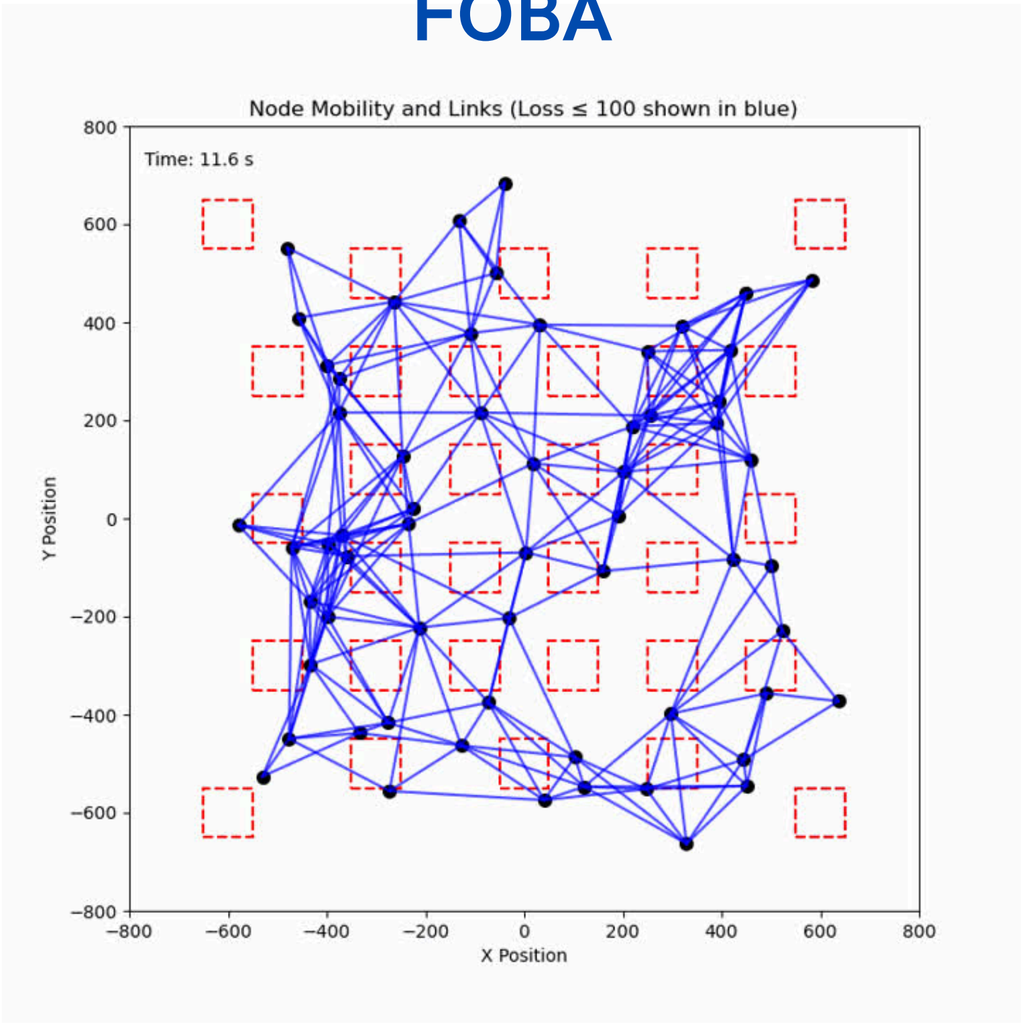
we see that now, the buildings does affect the loss value



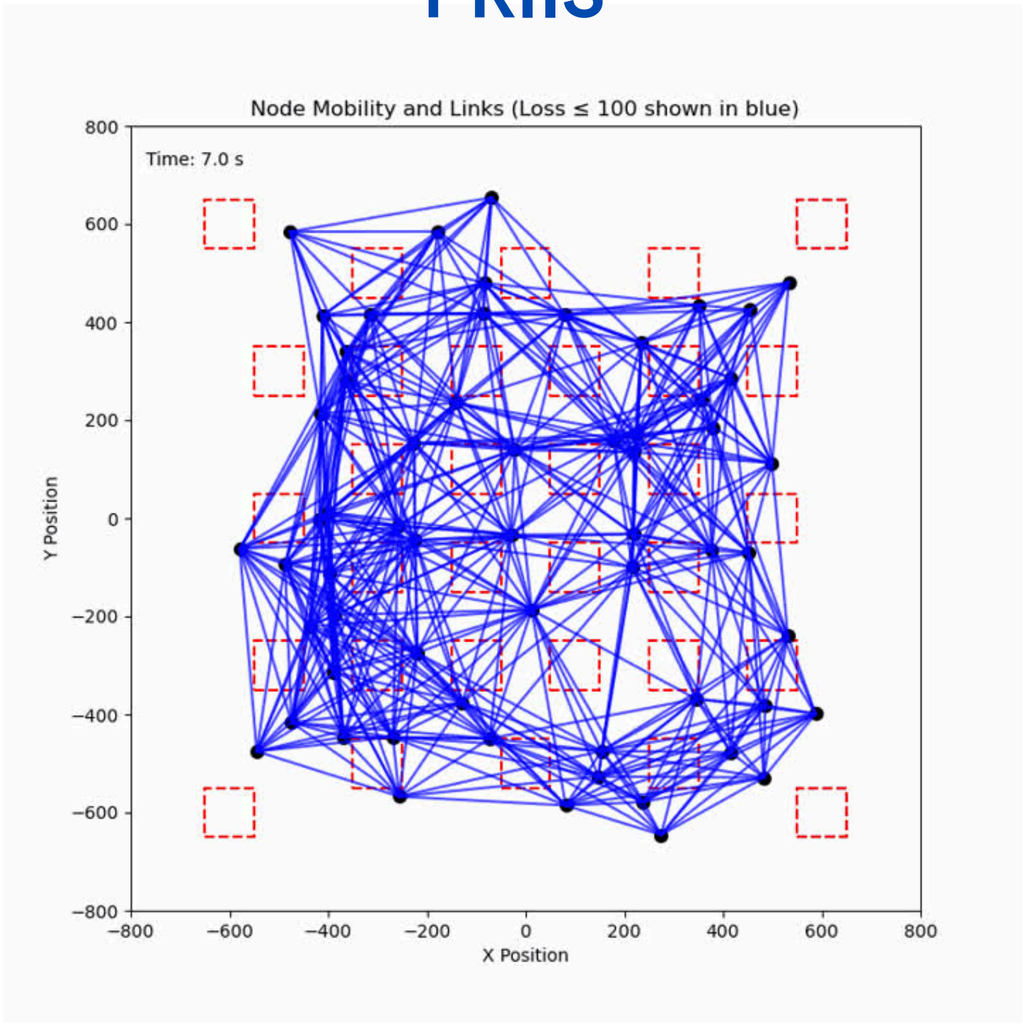


4. Implementation and results

FOBA



FRIIS



Performance tests

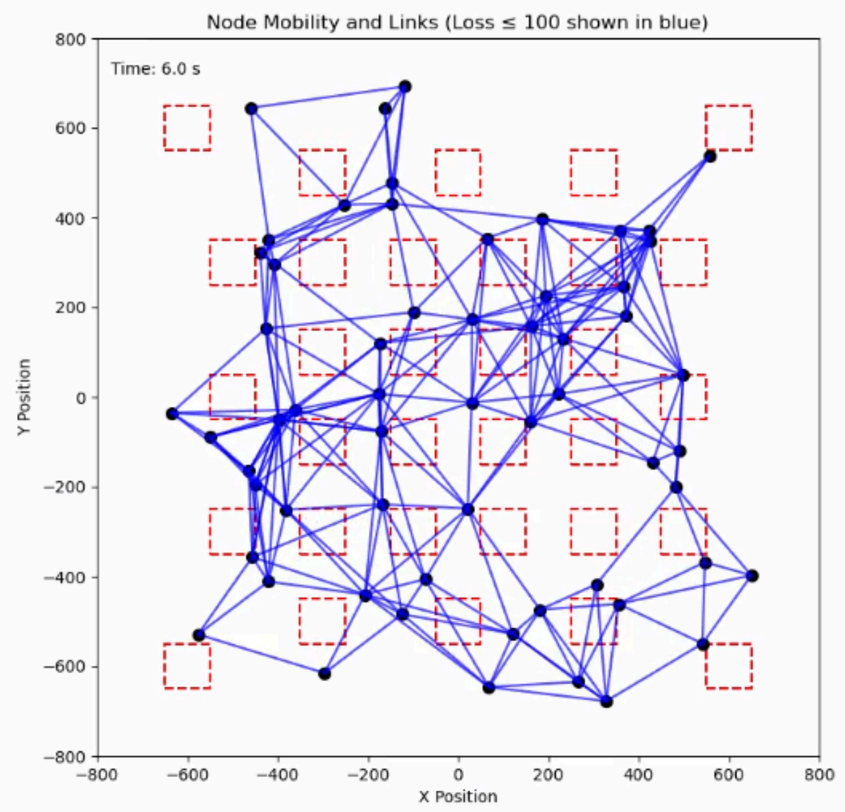


Figure 9 : Scénario complexe avec le modèle FOBA

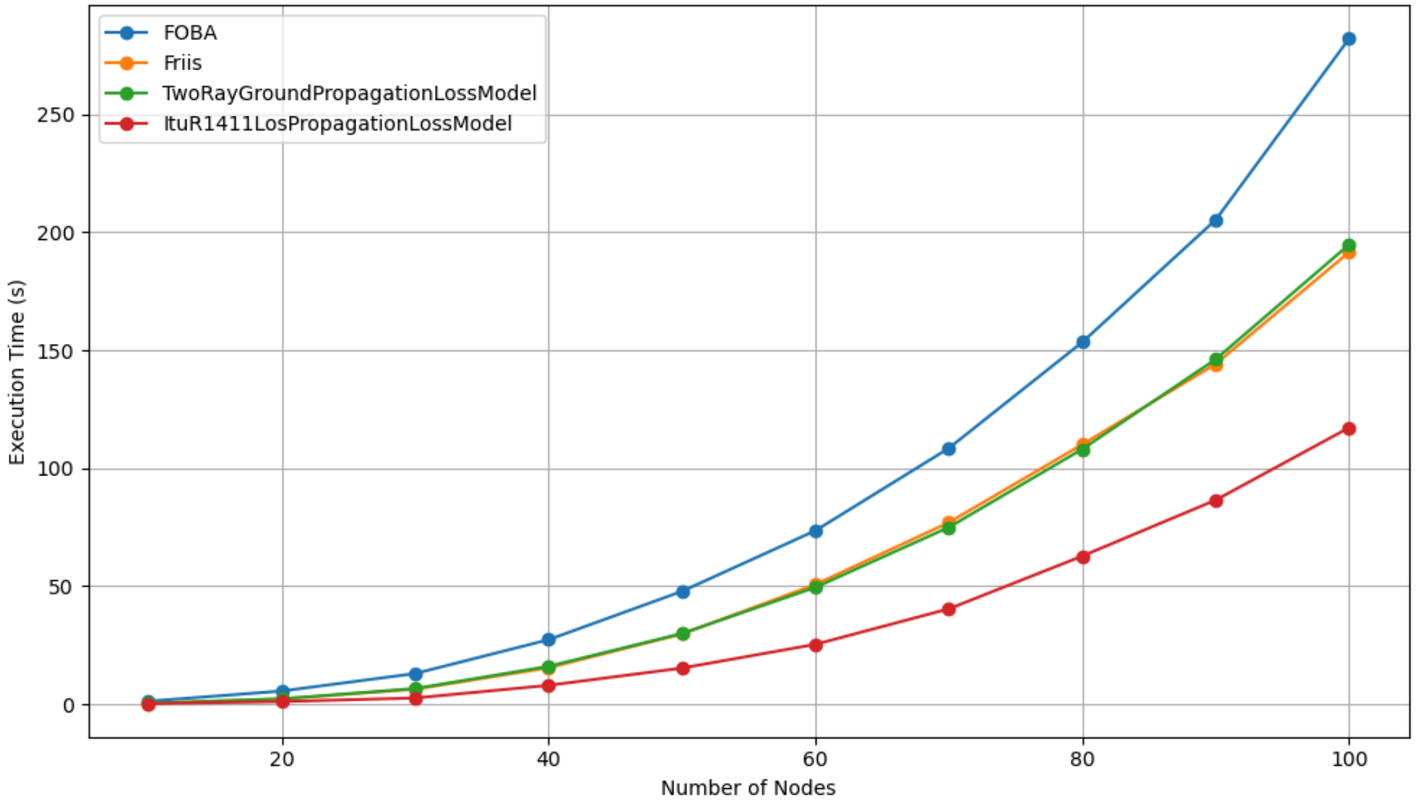


Figure 10 : Comparaison des performances de FOBA avec d'autres modèles

Path loss modeling

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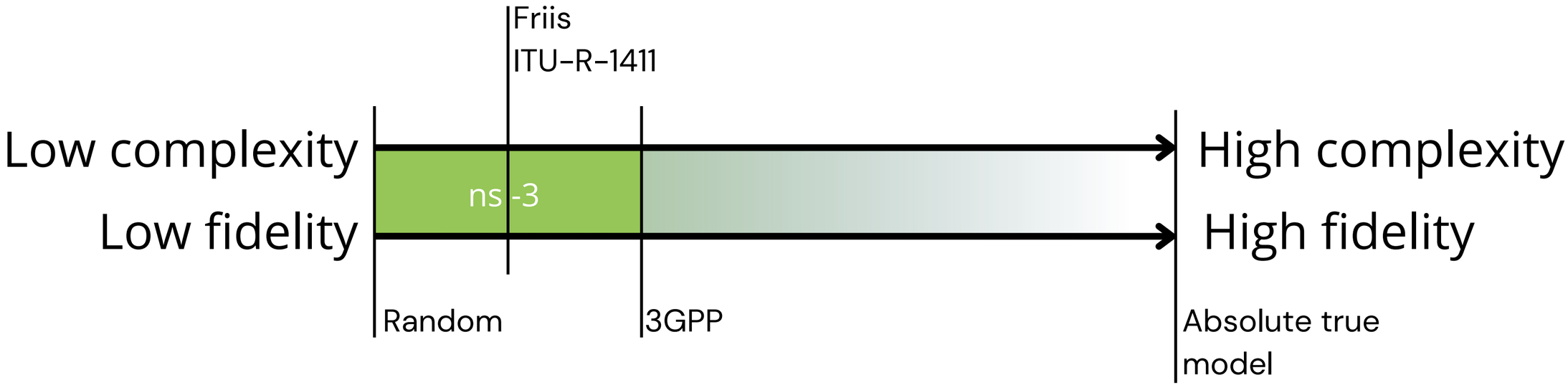

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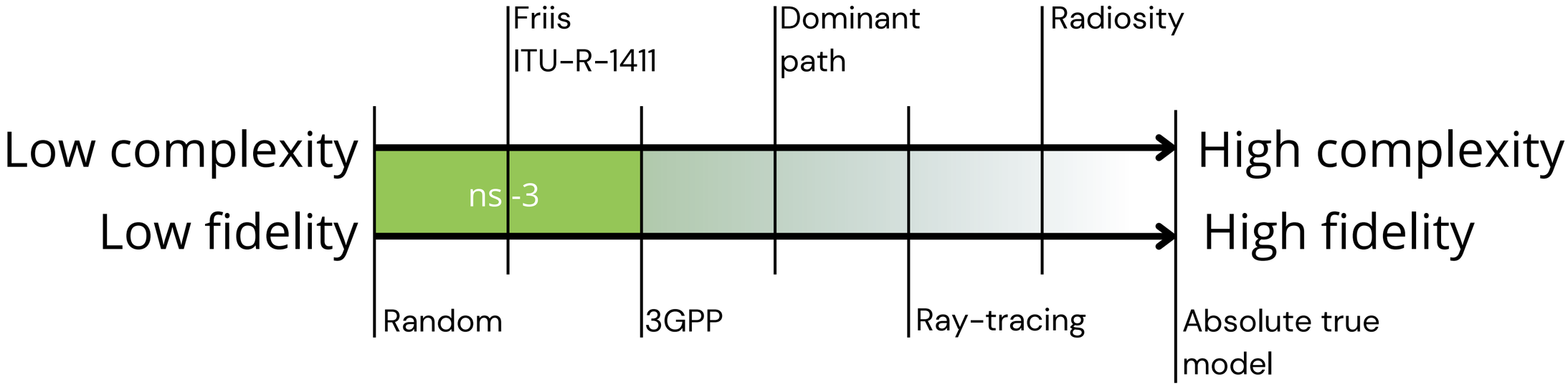

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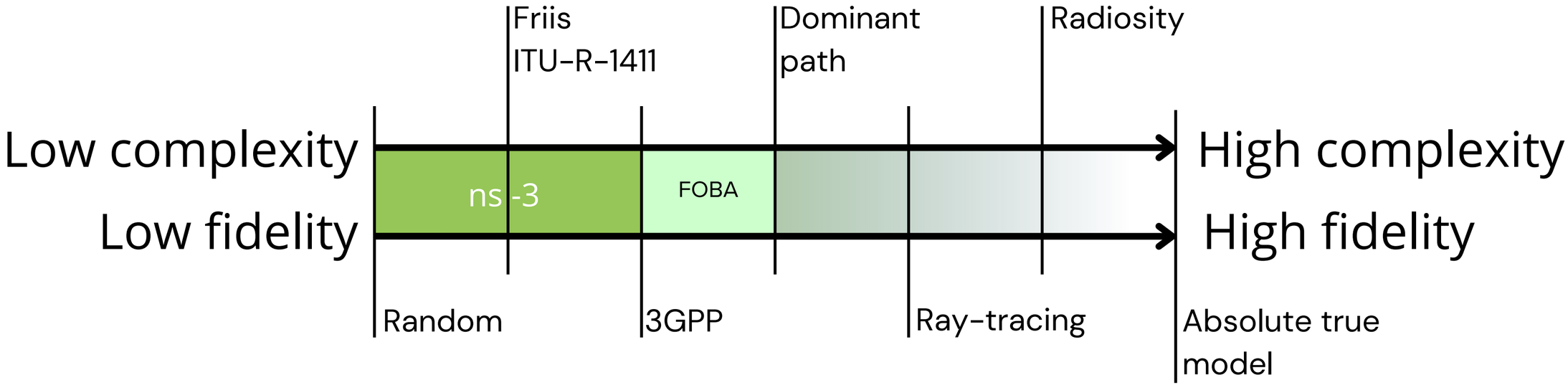
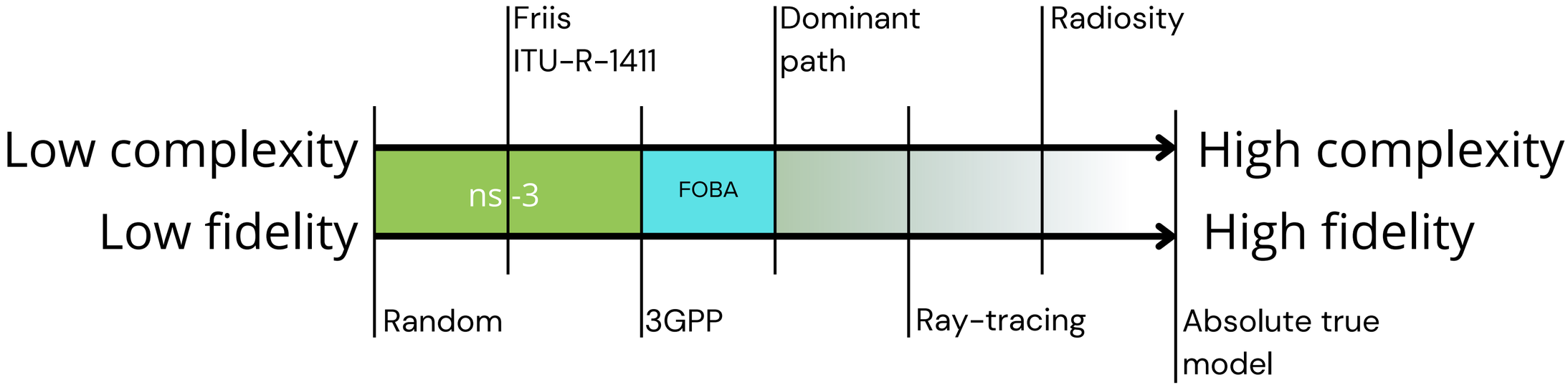


Figure 2 : Visual mapping of the different loss model approaches

Path loss modeling



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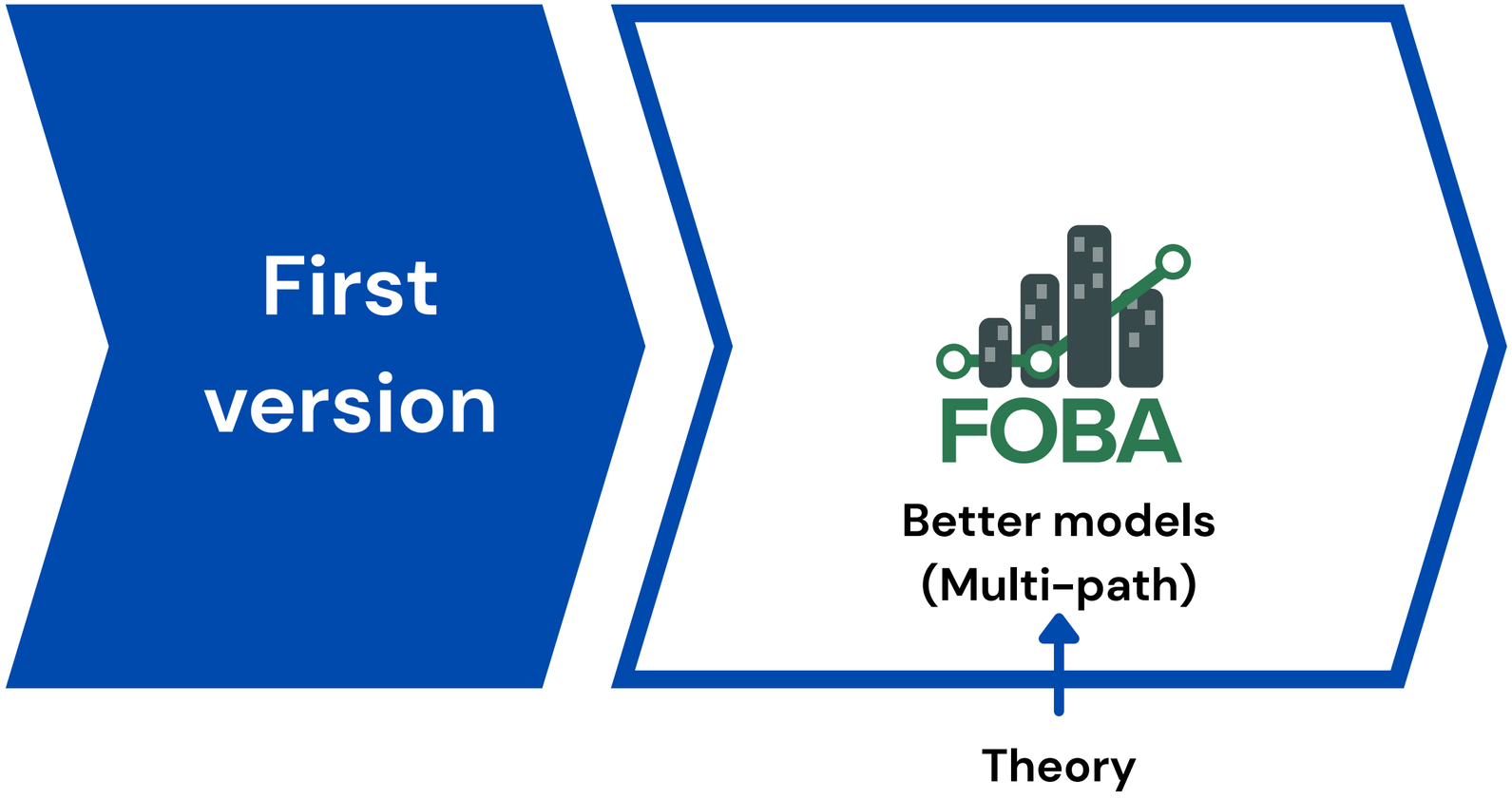
Outlook

5. Outlook

First version

5. Outlook



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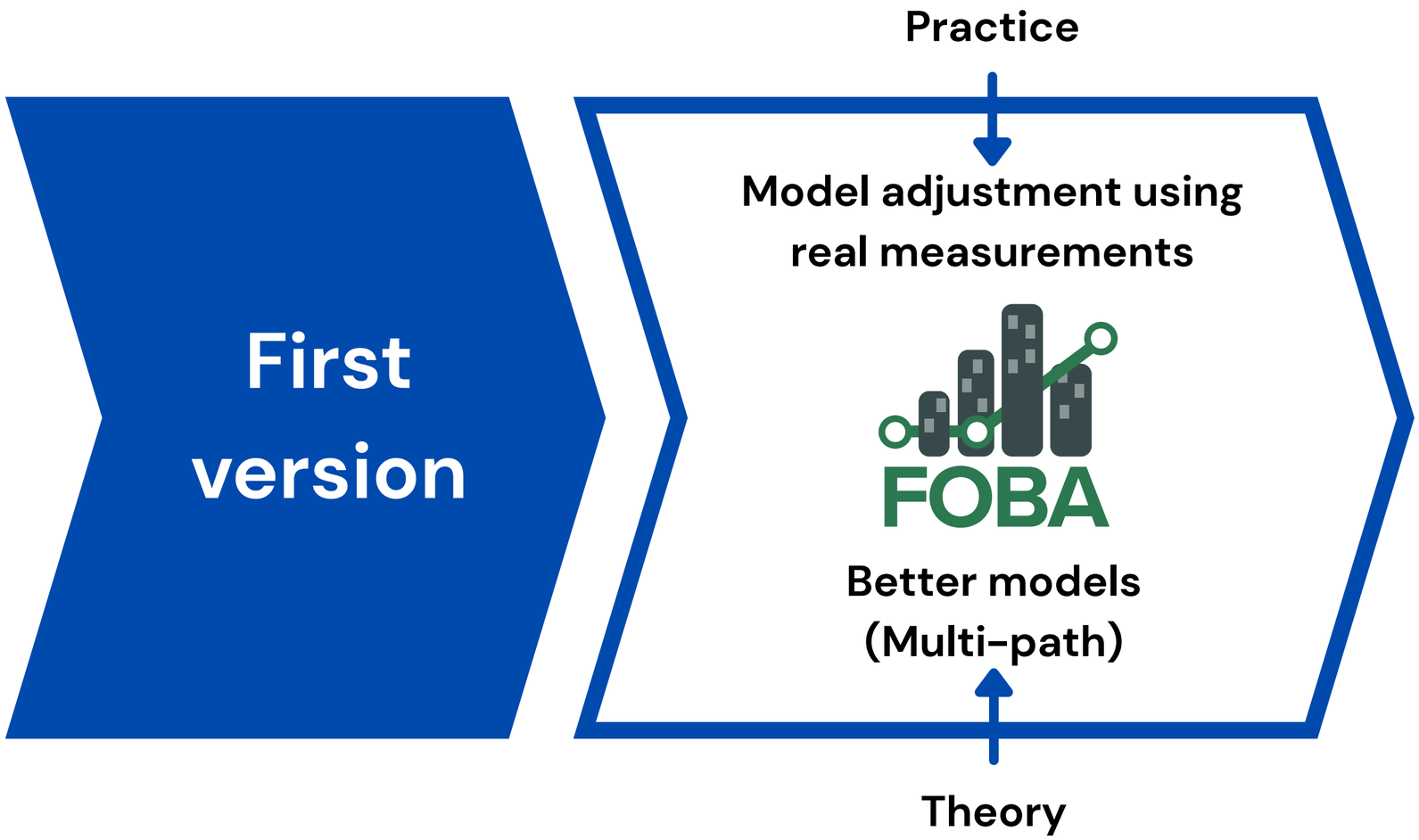
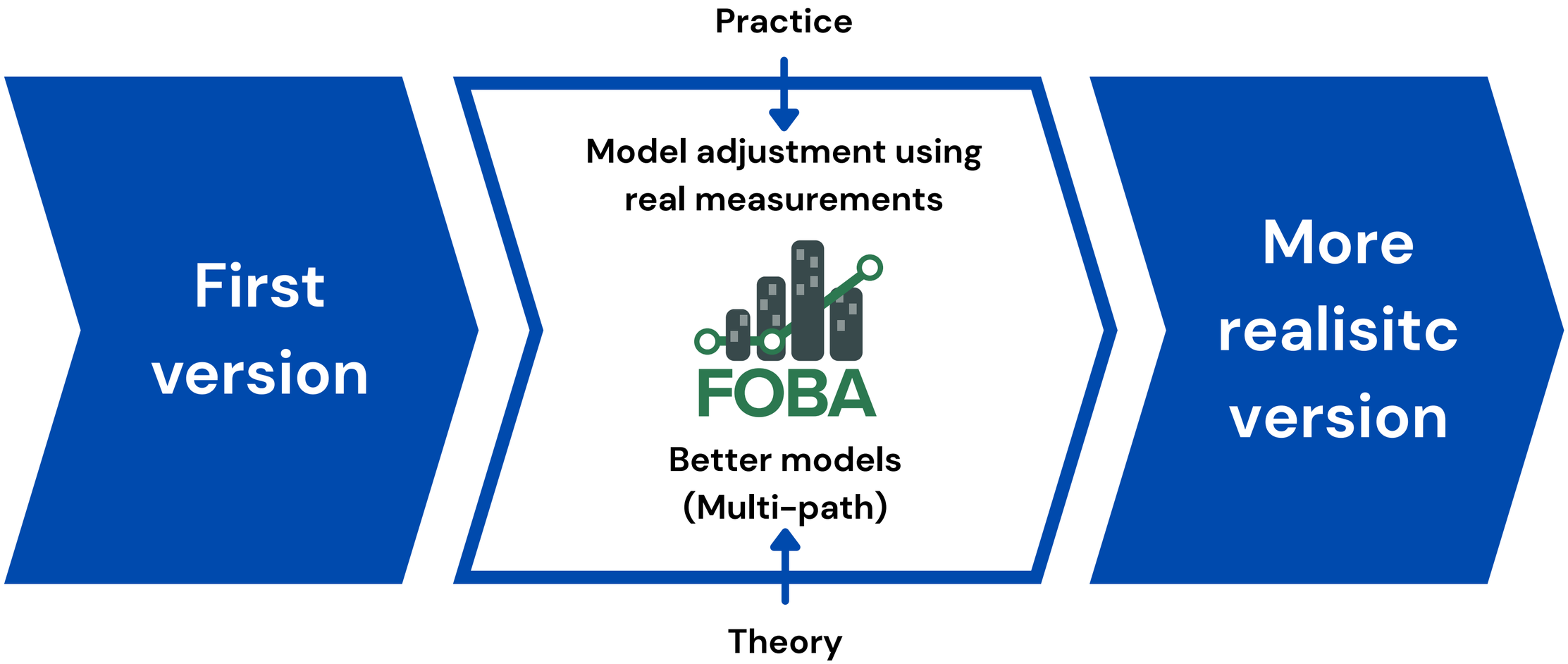

Practice
First version
Model adjustment using real measurements
FOBA
Better models (Multi-path)
Theory

5. Outlook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FOBA

First-Order Building Aware Path Loss Model

Available on GitHub

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Questions ?

Acknowledgments

This work has been co-funded by ONERA and the French Ministry of Defence's Innovation Agency (AID).

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Simulation Description

Simulation Parameter	Value
ns-3 Version	3.44
Wi-Fi Standard	802.11g
Simulation time	400 s
Routing Protocol	AODV
Loss models	FOBA, Friis
Application	CBR (1 source, 1 sink)
Transport Protocol	UDP
Packets size	1024 (bits)
Packets rate	50 packets per seconds
Mobility model	ConstantPositionMobilityModel

Simulation Description

Simulation Parameter	Value
ns-3 Version	3.44
Wi-Fi Standard	802.11g
Simulation time	300 s
Routing Protocol	OLSR
Loss models	FOBA, Friis, Two Ray Ground, ITU-R 1411
Application	CBR (4 sources, 4 sinks)
Transport Protocol	UDP
Packets size	1024 (bits)
Packets rate	50 packets per seconds
Mobility model	RandomWalk2dOutdoorMobilityModel

2.ns-3, signal propagation and path loss modeling

Signal propagation

- Decrease with the distance
- Obstacles may interfere with the strength of the signal

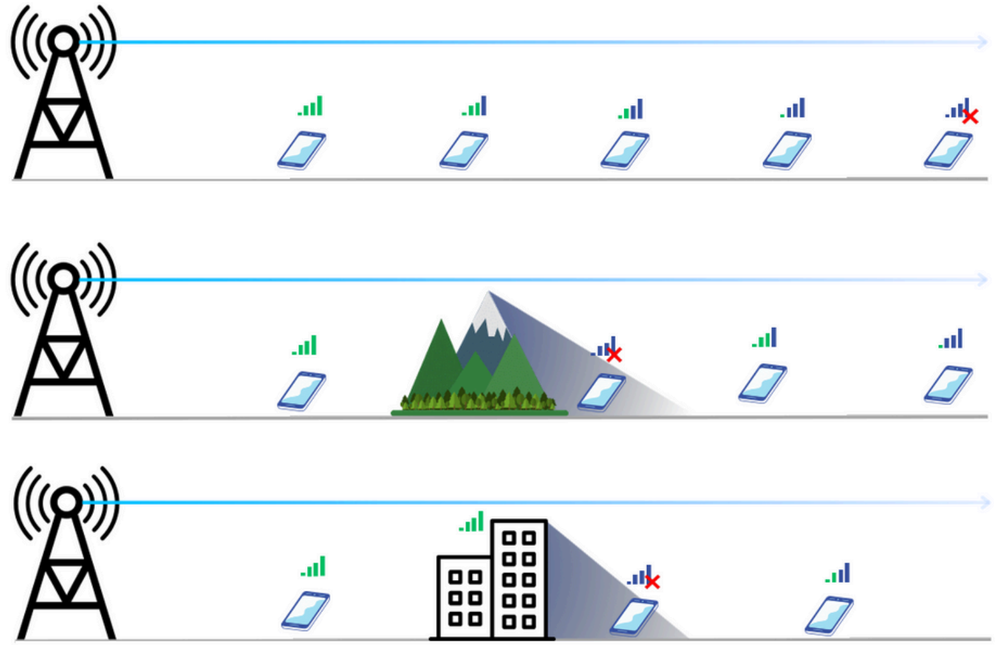

Figure 1 : Visual representation signal strength in multiple settings

2.ns-3, signal propagation and path loss modeling

Transparent buildings

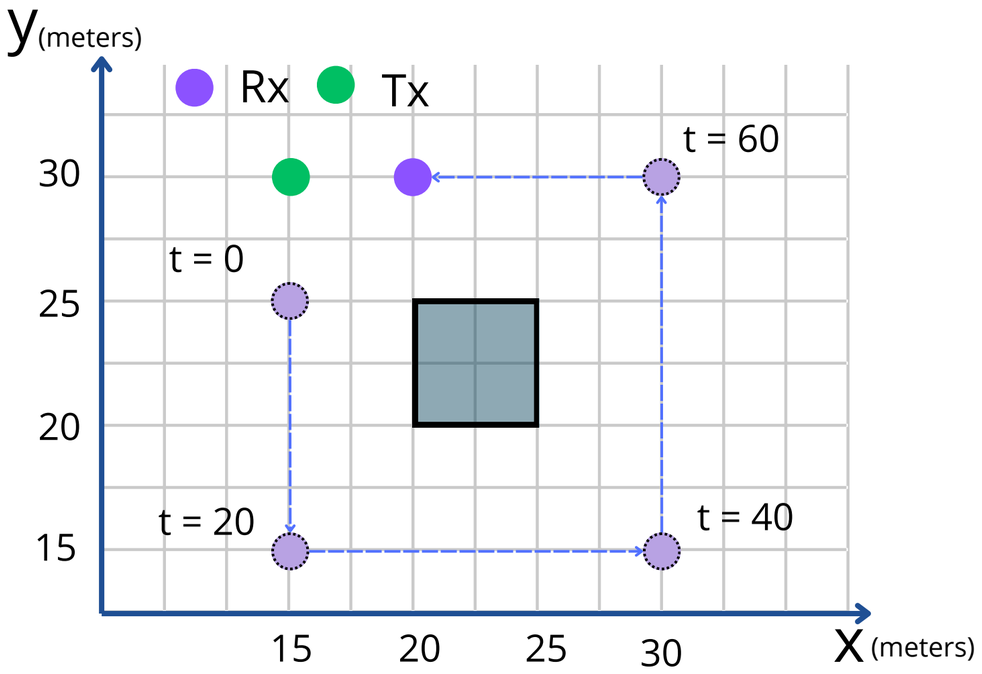

Figure 2 : Visualisation d'un scénario de mobilité

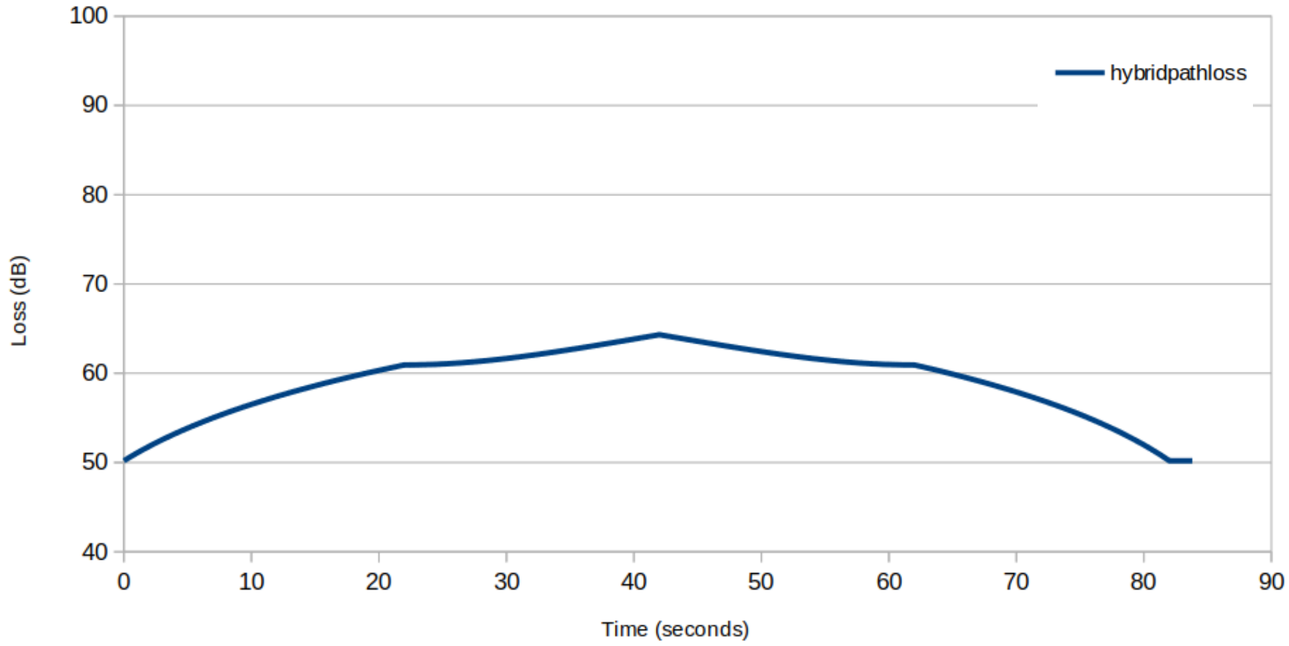

Figure 3 : Valeurs de pertes en fonction du temps