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BIM Process for acoustic problems

Costantino Carlo Mastino[1], Antonino Di Bella[2], Luca Barbaresi[3], Giovanni Semprini[4], Andrea Frattolillo[5]

[1]DICAAR - University of Cagliari
mastino@unica.it
[2]DII – University of Padova
antonino.dibella@unipd.it
[3]DIN – University of Bologna
luca.barbaresi@unibo.it
[4]DIN – University of Bologna
giovanni.semprini@unibo.it
[5]DICAAR – University of Cagliari
andrea.frattolillo@unica.it

Abstract
Recent communications from the European Community oblige Member States to use the BIM (Buildilg Information Modeling) in the realization of public works. At European level countries like the United Kingdom, Sweden, The Netherlands and Denmark have already used BIM models for the management of the built heritage for several years. At extra-European level China, the USA and in particular Singapore have long taken the road to digitization of buildings and more generally of the built heritage. What drives to digitalization is saving money that these digital procedures allow in the different phases of life of buildings. The present work is aimed at outline an overview of the use of Open Source BIM models regarding the management of acoustic problems, both for the acoustic performance of buildings and from the point of view of environmental acoustics. In the work the main open source data formats available today, such as IFC and CityGML, some of which are recognized as standard from ISO. The data concerning the acoustic issues present in the various formats will also be analysed and one Data Template will be proposed for the lack of parts or missing according to the provisions of the various international standards.

Keywords: BIM, IFC format, BIM rules, Acoustic whit BIM, acoustic digitalization.

1 Introduction

Acoustic comfort is linked to the environment and life quality. The health implications generated by noise are increasingly leading to urban planning and building design with particular attention to acoustic aspects. Among the different types of source, the noise generated by road traffic, according to the data published by EEA [1], is the most frequent source of outdoor noise pollution in Europe and affects different aspects of population health [2, 3] and on the quality of the environment built in terms of decrease in value [4]. The digitization of building processes adopted by the European Community with Directive 2014/24/EU [5] leads to a process of innovation that, among the various themes, includes the management [6] and design of measures to control and limit noise pollution. The BIM (Building Information Modelling) derives as a consequence of economic aspects. Its application has made clear the amount of savings achievable in the management phase of a property. Today more than ever it constitutes an innovative tool that is increasingly used for the solution of acoustic problems both on a building scale and on an urban scale. More and more

often the BIM model is the starting point for the definition of the BPS (Building Performance Simulation) to estimate the performance of the building in the design phase [7]. One of the fundamental aspects of Building Information Modelling is to represent the building or the set of different buildings geometrically through the realization of a three-dimensional model [8-12,15] to which associate different types of information [16-18]. In this work the main BIM Open Source formats [13,16,19,20] used for interoperability and exchange from the various BIM Authoring platforms are presented. For the main IFC [21] and CityGML [11,14] data formats and field of application are also reported. Nowadays, different reference standards [22-40] and procedures are available today for environmental acoustics and building acoustics design. They are applicable both a in the concept and project phase, as well as in the phase of on-site measurements [12,14,20,41-43].

2 Procedures and data for the use of the BIM models

Bazjanac since 2001 [44] has identified time savings in the order of 75% for the creation of the building geometry in small or medium buildings through the correct application of automated processes. From the acoustic point of view the use of BIM to create BAM (Building Acoustic Modelling) is currently being studied by researchers and producers of software tools.
In Figure 1 is shown the logical structure of a BIM model referring to the building. Within a model, different types of zoning can coexist according to different objectives such as energy, fire safety and acoustic aspects [18,20]. The zoning is simply the logical grouping of the rooms that in IFC language are called SPACE "IFCSpace".

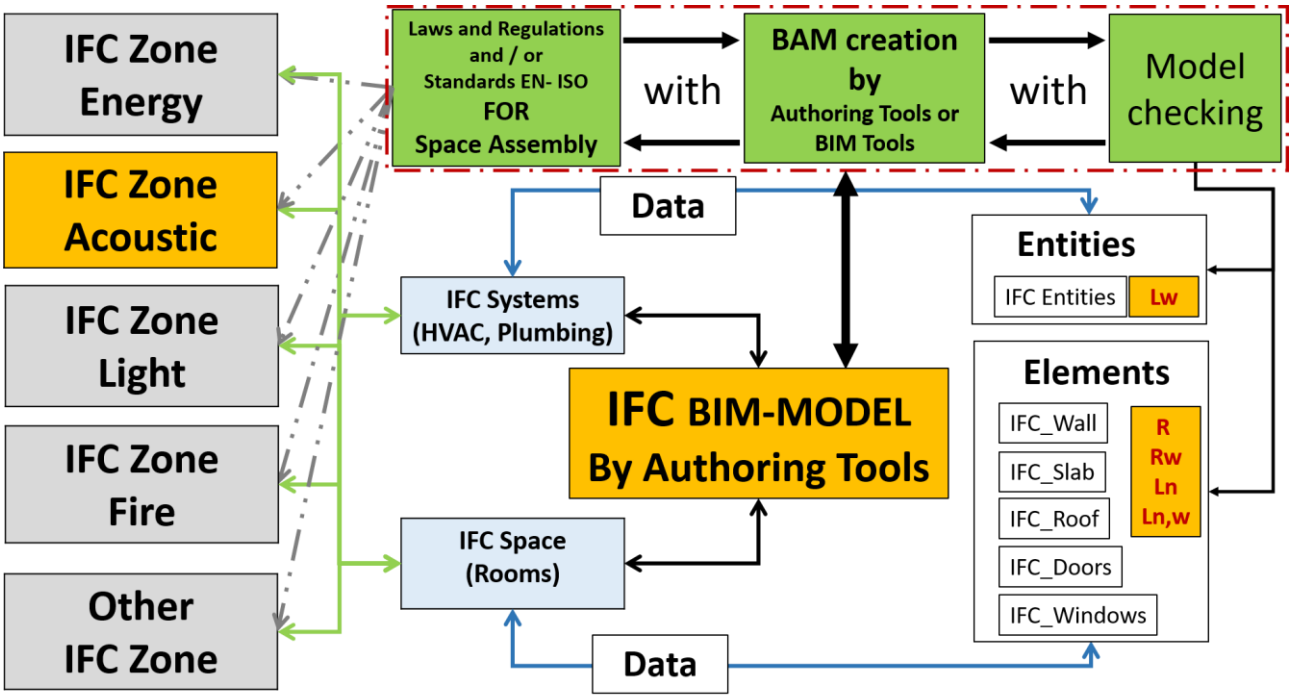

Figure 1 – Data Structure IFC BIM Model for BAM creation and Model Checking.

Figure 2 shows all the parameters (information) and the geometry that the BIM model should contain for the calculation of the performance during the project and for the instrumental verification phase (on-site measurements) of the various parameters, as well as the acoustic classification at end of construction work [41]. Note that, while for the project phase it is essential to know the performance parameters of the building

components and plant systems for the purpose of the predictive calculation, for the verification phase the knowledge of the geometry is required as the performance is verified with on-site measurements.

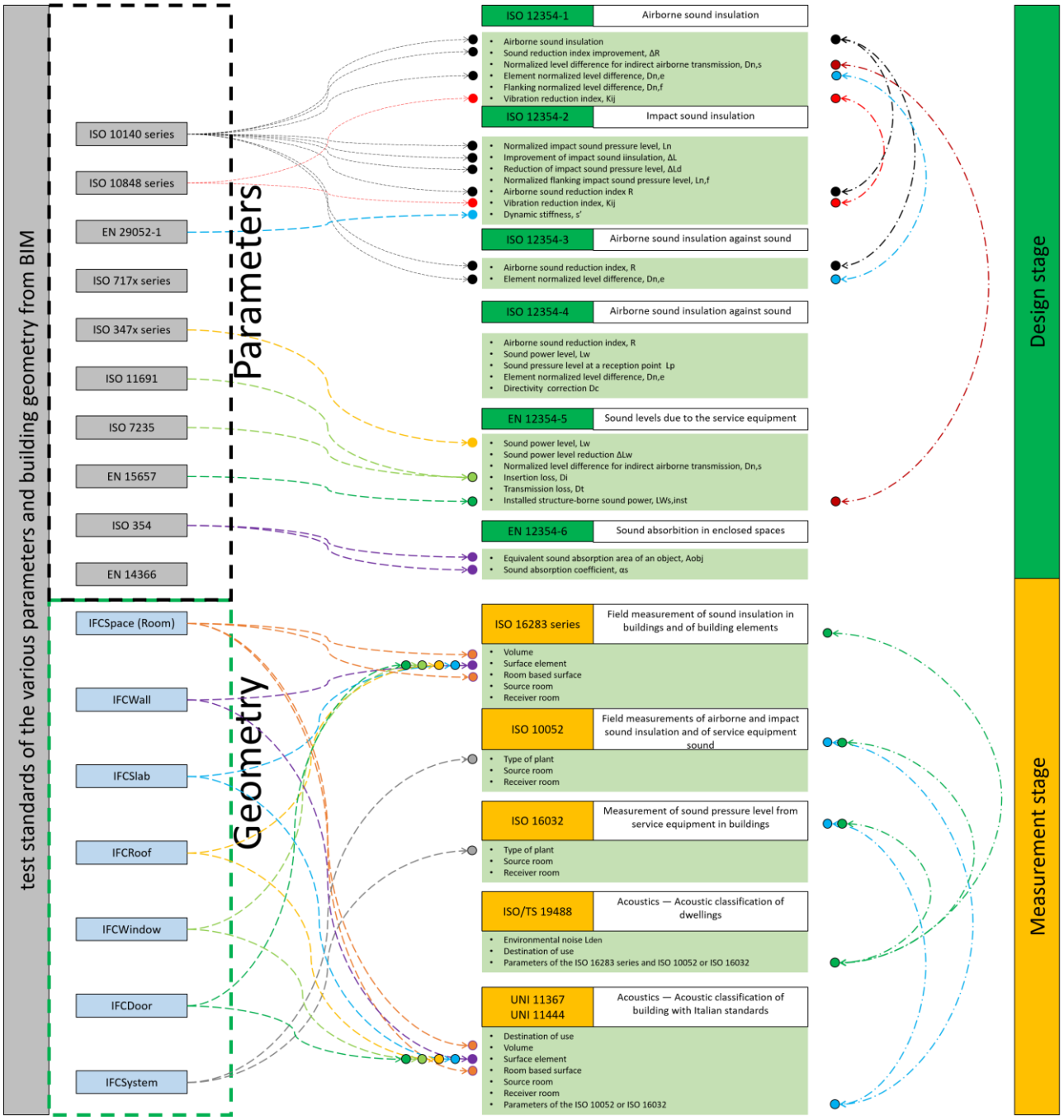

Figure 2 – Acoustic data needed to IFC BIM Model for BIM Validation, Clash Detection and Code Checking.

In the final verification phase, thanks to the use of the BIM model, it is possible to choose which elements submit to verification tests. The criteria applied for the choice of these elements can be different, for example by the analysis of the room/element geometry or based on the results of predictive calculations carried out in the project phase [22], according with the standards of the ISO 12354 series [25-30].

Figure 3 shows the workflow for the generation of the BAM acoustic model [18,20,41-43,45]. The work tool analyses the BIM model in IFC format [19-21] and returns the acoustic zoning, highlighting missing information and integrating missing or lacking data.

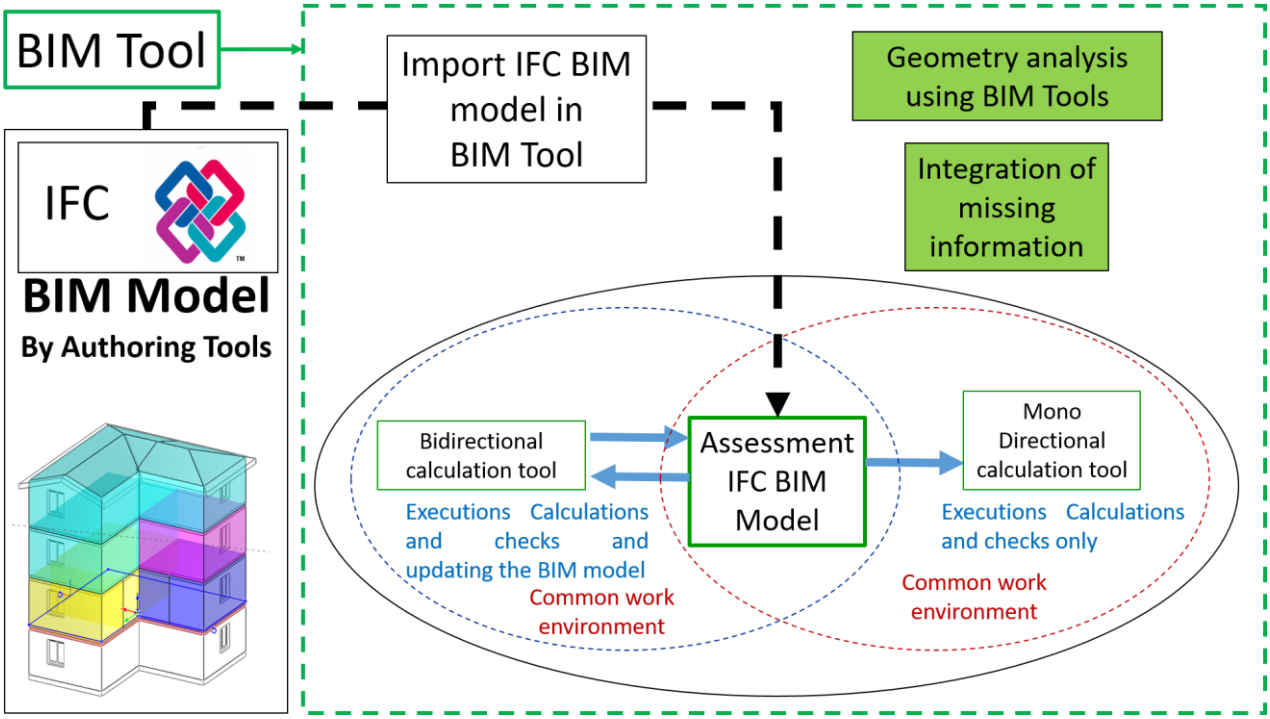

Figure 3 – BIM Tools: generation of the BAM model and update of the BIM model.

The City Geography Markup Language (CityGML) [46] is a concept for the modelling and exchange of 3D city (Building Information Modelling at the city level or neighbourhood) and landscape models that is quickly being adopted on an international level. CityGML is a common information model for the representation of 3D urban objects. It defines the classes and relations for the most relevant topographic objects in cities and regional models with respect to their geometrical, topological, semantical and appearance properties. It includes generalization hierarchies between thematic classes, aggregations, relations between objects, and spatial properties. In contrast to other 3D vector formats, CityGML is based on a rich, general purpose information model in addition to geometry and graphics content that allows to employ virtual 3D city models for sophisticated analysis tasks in different application domains, like simulations, urban data mining, facility management, and thematic inquiries. Targeted application areas explicitly include: urban and landscape planning; architectural design; tourist and leisure activities; 3D cadastres; environmental simulations; mobile telecommunications; disaster management; homeland security; vehicle and pedestrian navigation; training simulators; and mobile robotics. CityGML is realised as an open data model and XML-based format for the storage and exchange of virtual 3D city models. It is implemented as an application schema for the Geography Markup Language version 3.1.1 (GML3), the extendible international standard for spatial data exchange issued by the Open Geospatial Consortium (OGC) and the ISO TC211 [47]. CityGML is an official OGC Standard and can be used free of charge. Figure 4 shows an example of information modelling at urban scale. The model shown with the Google Earth Pro application [48] represents in the urban scale huge by integrating all a series of non-geometric information and the three-dimensional geometry. Currently the two formats are not really interoperable and will probably never be, as they have The CityGML format is currently not compliant with an ISO standard as the IFC format but it is likely that it becomes in a near future. The interoperability between CityGML and IFC, when this is

necessary can in be implemented through the BIM Tools applications, in particular Web Application [49], that allow to read both IFC and CityGML formats.

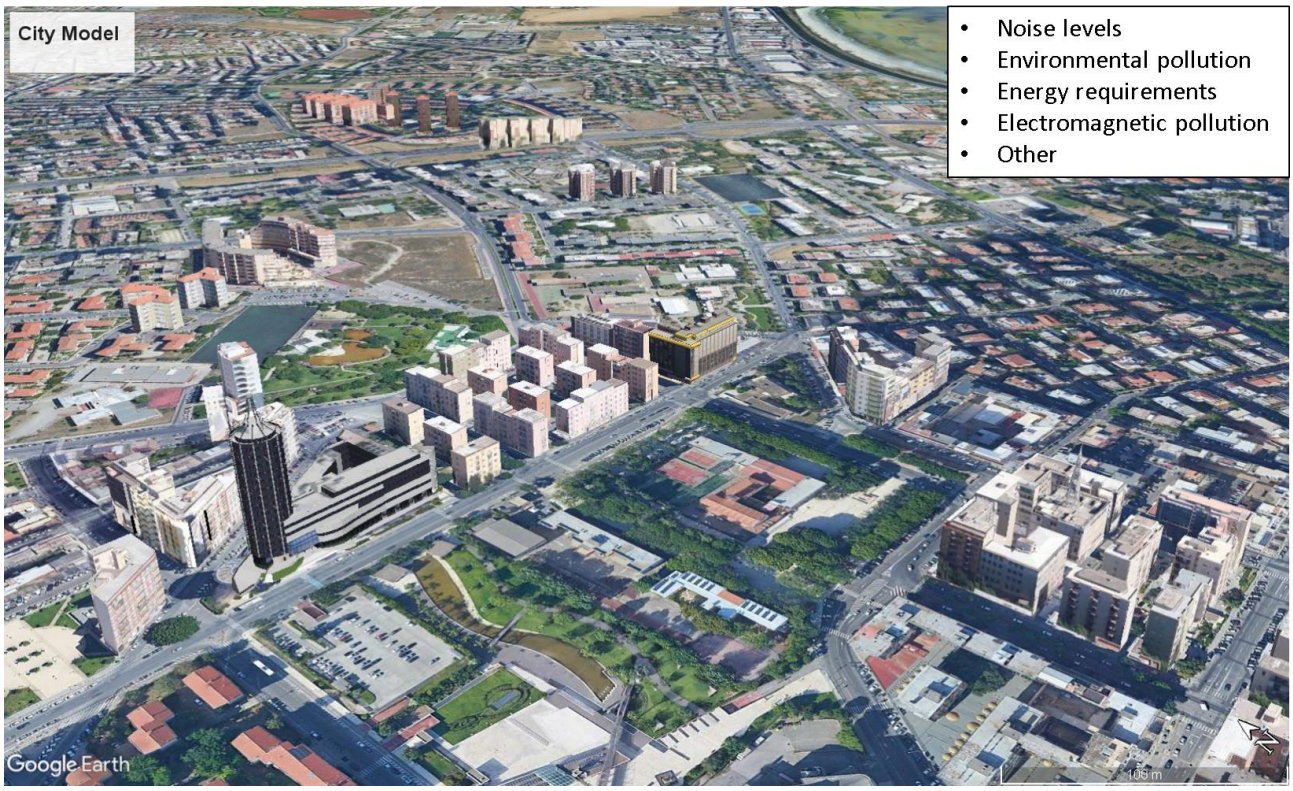

Figure 4 – Example of City Model.

Figure 5 shows the flow of information that a BIM tool, capable of read the two open formats mentioned above, is able to manage in order to perform analyses and assessments on a single building, connecting it to the environmental context where it is located.

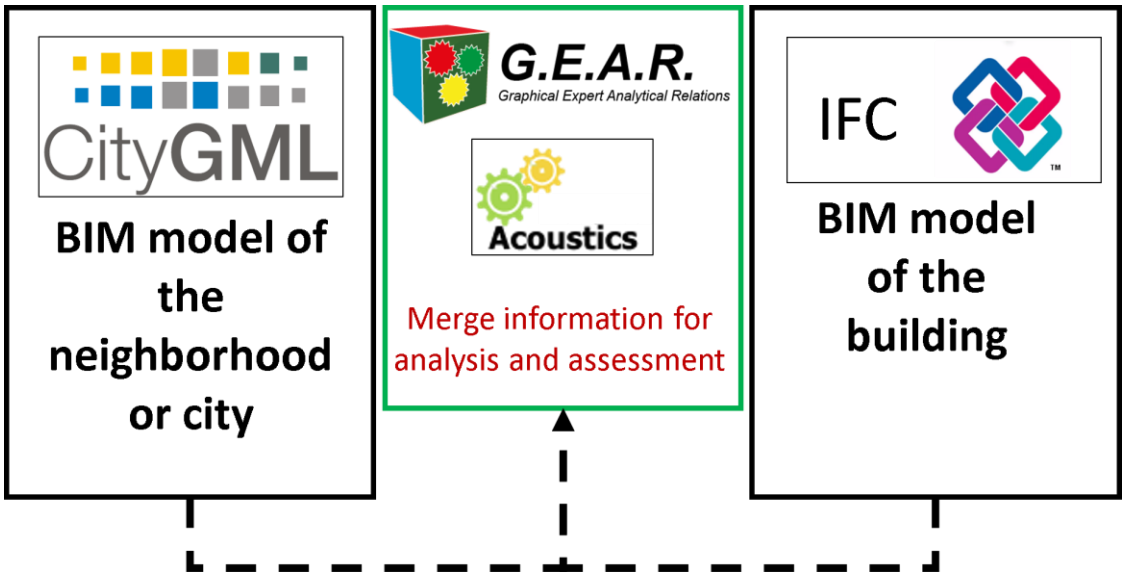

Figure 5 – Flow of the BIM tools data for read and use the information of CityGML and IFC.

Through the use of a specific BIM Tools it is possible to perform simulations of building acoustic performances [22,41,42] and, at the same time, to evaluate the sound pressure levels due to road traffic or other sources [1,2,23,24,50-53], both calculated and measured, which affects a given neighbourhood or an area of the city. As a result, it is possible to ensure adequate sound insulation of the facade of a building and assess whether the performance provided for each building in an area is sufficient or whether it is necessary to increase it. Alternatively, traffic noise mitigation measures can be taken when existing buildings are not sufficiently insulated.

3 Conclusions

The present work analysed the BIM digital procedures for use in the field of building acoustics and environmental acoustics. The open formats and the interoperability of the information combined with the analysis of the reference regulatory standards for the various themes showed how the use of BIM procedures can be very advantageous in terms of time savings and number of scenarios processed to support the decision-making process. The implementation of this methodology, on which numerous countries stable investing, suggest that in the future the entire design and management process will be applied to the "digital" buildings, as well as to the management of noise-related environmental problems. In conclusion, from the results of several studies, it is clear that today many tools for performance calculating and information management in the acoustic field are oriented the use of interoperable BIM models. At the same time, it is observed that this process is also implemented at technical standards level, with the establishment of working groups dedicated to this topic.

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