**Ontology metrics - complete**

Following the DL expressivity enhancements, our ontology's formal structure expanded significantly. Comparing metrics for all three phases (PH2, PH3, FINAL) reveals substantial growth in complexity and coverage.

**Hierarchical structure of the preliminary ontology, along with associated metrics**

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**Core metrics evolution:**

* **Total axioms** show consistent growth across phases, increasing from 434 in PH2 to 531 in PH3 (22% growth), and finally reaching 778 in FINAL (a further 46% increase from PH3). This demonstrates significant expansion of the ontology's knowledge base.
* **Logical axiom count** also exhibits substantial growth, rising from 159 in PH2 to 193 in PH3 (21% growth) and then to 353 in FINAL (an 83% jump from PH3). This indicates a considerable increase in the complexity and expressiveness of the ontology.
* **Classes** expanded steadily from 27 in PH2 to 39 in PH3 (44% growth) and finally to 48 in FINAL (23% growth from PH3). This reflects the addition of new concepts and improved threat modeling capabilities.
* **Object properties** increased notably, from 5 in PH2 to 8 in PH3 (60% growth) and then to 19 in FINAL (a 138% rise from PH3), enabling richer relationship modeling and capturing more complex threat scenarios.

**Enhanced relationship modeling**

* **Object property axioms** saw significant expansion, particularly with introducing new functional (3) and transitive (2) properties in FINAL. This indicates a more nuanced representation of relationships between different entities.
* **Object property domains and ranges** increased substantially from 5 to 8 in PH3, and then to 17 each in FINAL, demonstrating a broader and more interconnected network of relationships.
* The introduction of **3 property chains** in FINAL allows for modeling complex threat relationships and attack paths, further enhancing the expressiveness of the ontology.

**Individual and class relationships**

* **Individual axioms** increased considerably from 117 in PH2 to 128 in PH3 (9% growth), and then to 258 in FINAL (102% growth from PH3). This reflects the addition of more specific instances and real-world data to the ontology.
* **Class assertions** grew steadily from 64 in PH2 to 73 in PH3 (14% growth) and then to 101 in FINAL (38% growth from PH3), indicating a more detailed classification of entities within the ontology.
* **Object property assertions** expanded significantly from 21 in PH2 to 25 in PH3 (19% growth), and then to 107 in FINAL (a substantial 328% increase from PH3), reflecting richer relationship modeling and a more interconnected knowledge graph.