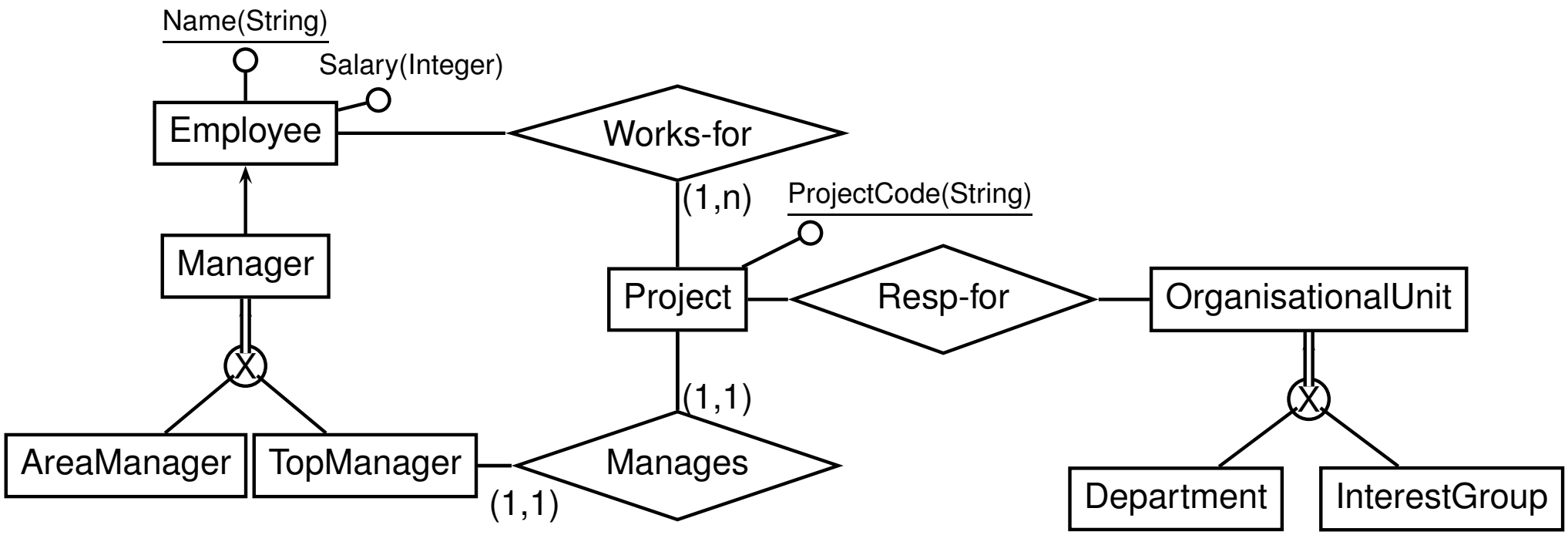
Temporal Axioms



A manager must be qualified, i.e. should have passed a period as an employee:

$$\texttt{Manager} \sqsubseteq^* \texttt{Qualified}\ \mathcal{S}\ (\texttt{Employee} \sqcap \neg\texttt{Manager})$$

Managers are the employees who do not work for a project (she/he just manages it):

$$\texttt{Employee} \sqcap \neg(\exists^{\geq 1}[\texttt{emp}]\texttt{Works-for}) \sqsubseteq^* \texttt{Manager} \ / \ \texttt{Manager} \sqsubseteq^* \neg(\exists^{\geq 1}[\texttt{emp}]\texttt{Works-for})$$

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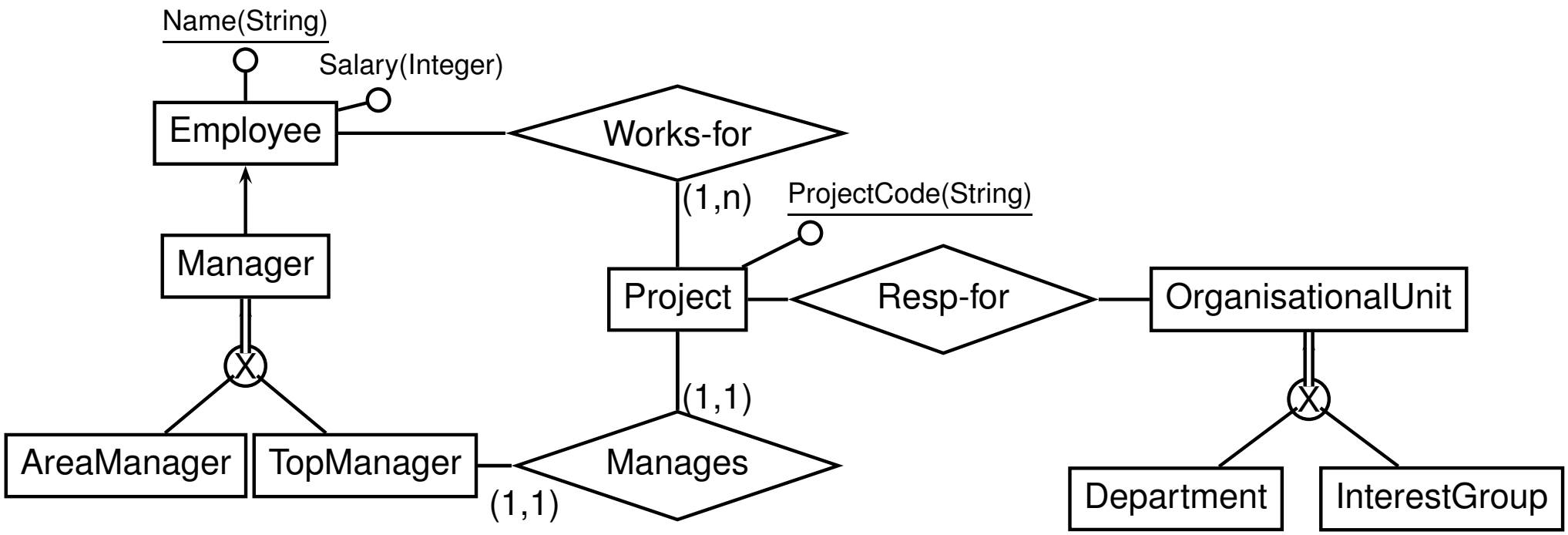

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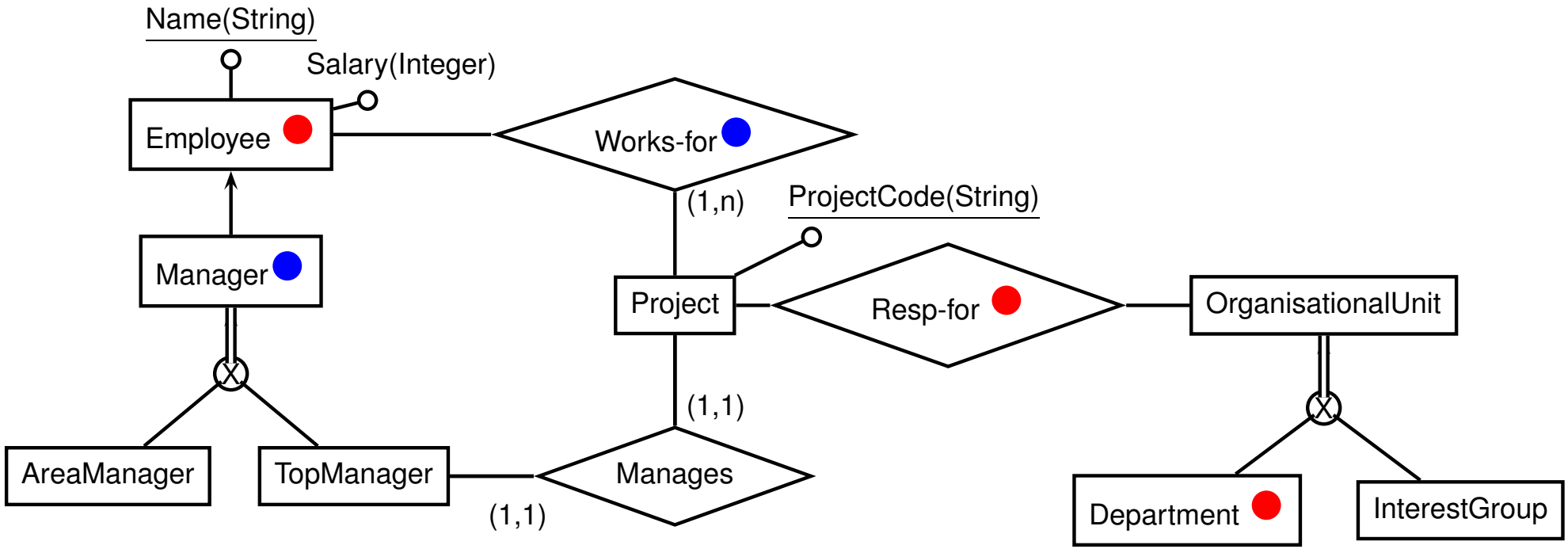
$\rightsquigarrow$ A top manager worked in a project before managing some (possibly different) project:

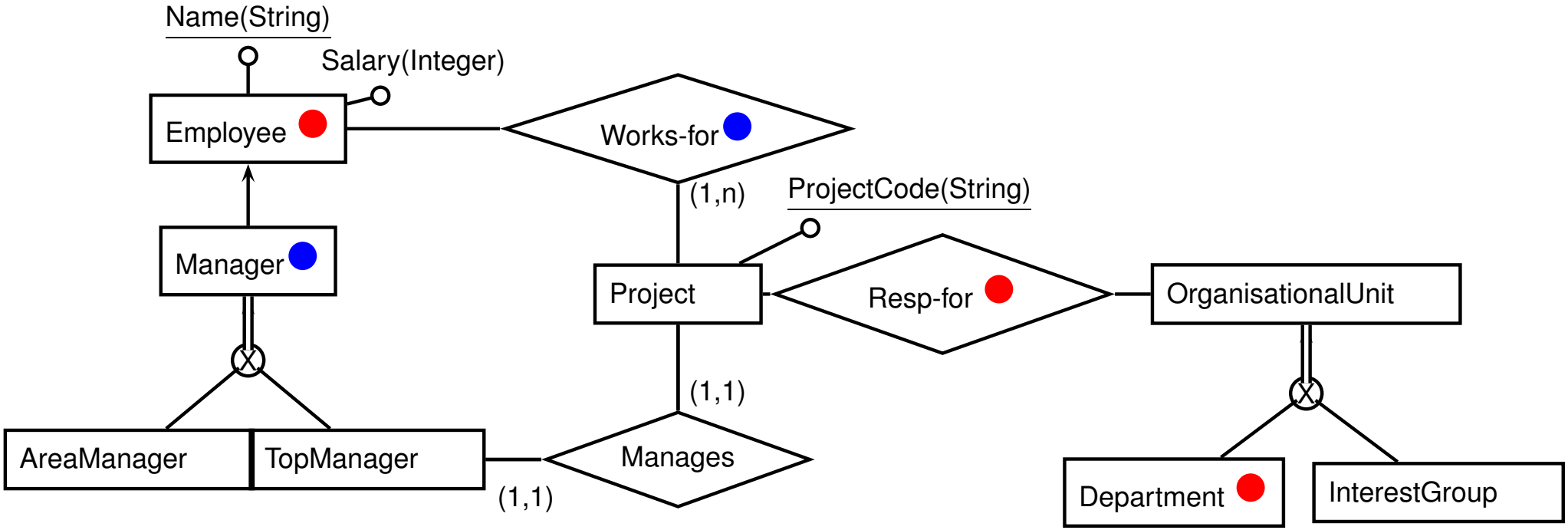
$$\Sigma \models \texttt{TopManager} \sqsubseteq^* \Diamond^- \exists^{\geq 1}[\texttt{emp}](\texttt{Works-for} \sqcap \texttt{act} : \texttt{Project})$$

Timestamps

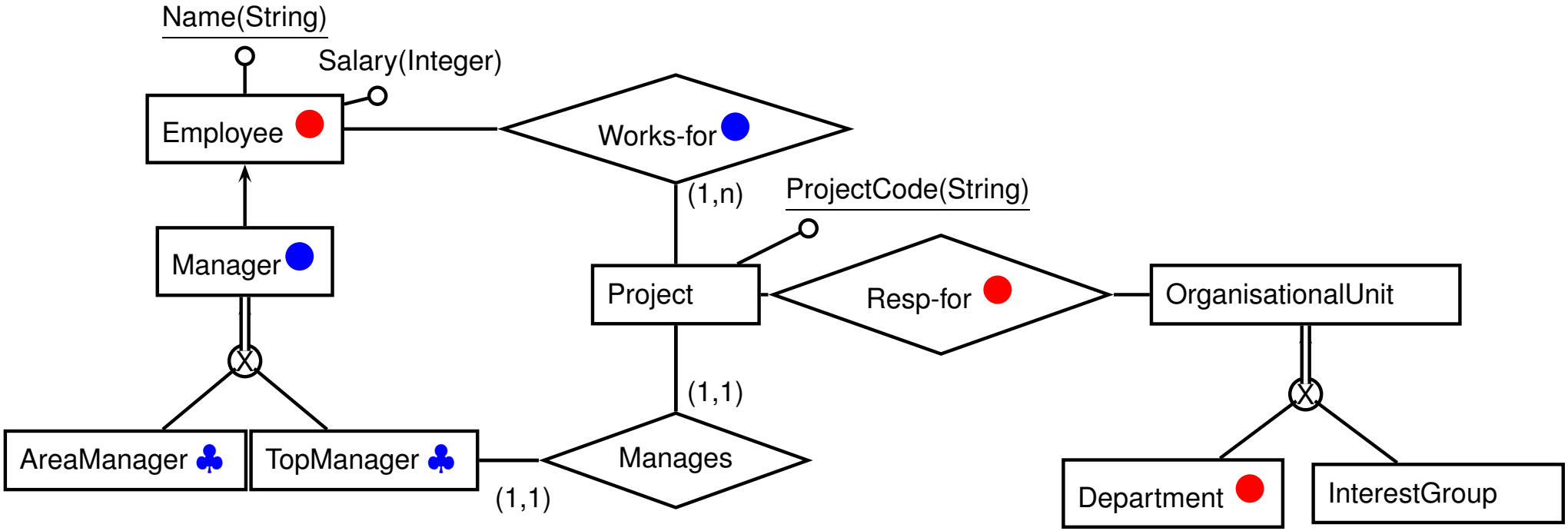


- $\texttt{Employee} \sqsubseteq^* (\Box^+\texttt{Employee}) \sqcap (\Box^-\texttt{Employee})$
- $\texttt{Department} \sqsubseteq^* (\Box^+\texttt{Department}) \sqcap (\Box^-\texttt{Department})$
- $\texttt{Manager} \sqsubseteq^* (\Diamond^+\neg\texttt{Manager}) \sqcup (\Diamond^-\neg\texttt{Manager})$
- $\texttt{Responsible-for} \sqsubseteq^* (\Box^+\texttt{Responsible-for}) \sqcap (\Box^-\texttt{Responsible-for})$
- $\texttt{Works-for} \sqsubseteq^* (\Diamond^+\neg\texttt{Works-for}) \sqcup (\Diamond^-\neg\texttt{Works-for})$

Inference with Timestamps

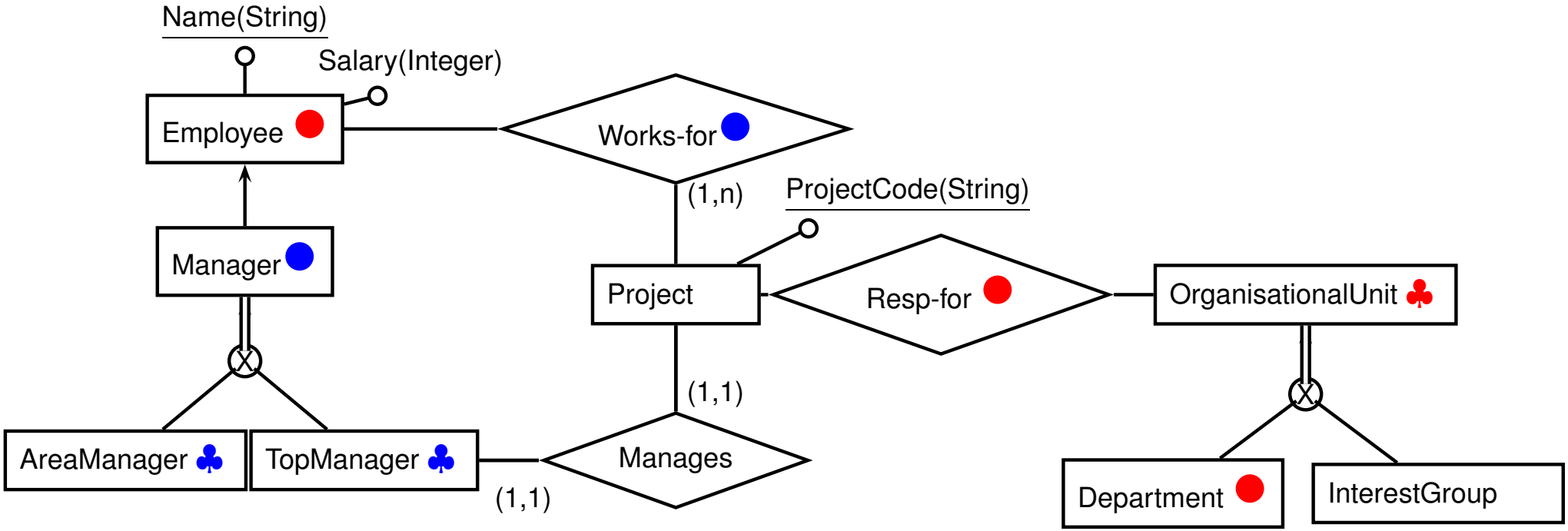


Inference with Timestamps



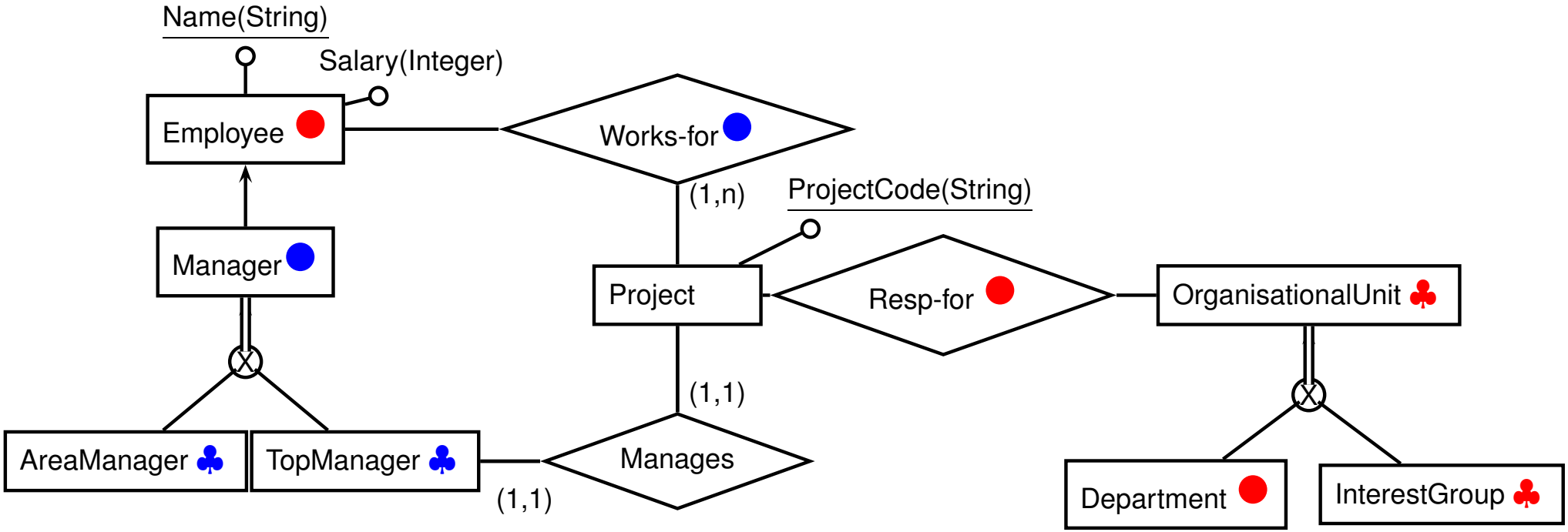
- Sub-entities of temporary entities must be temporary.

Inference with Timestamps



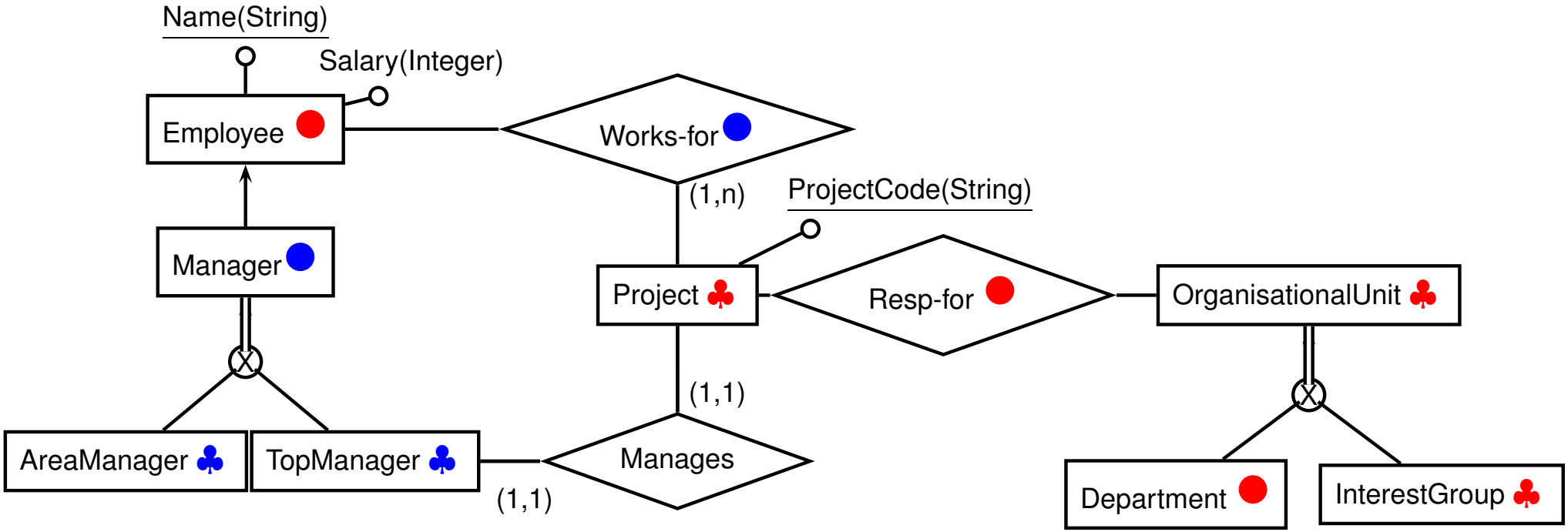
- Sub-entities of temporary entities must be temporary.
- Super-entities of snapshot entities must be snapshot.

Inference with Timestamps



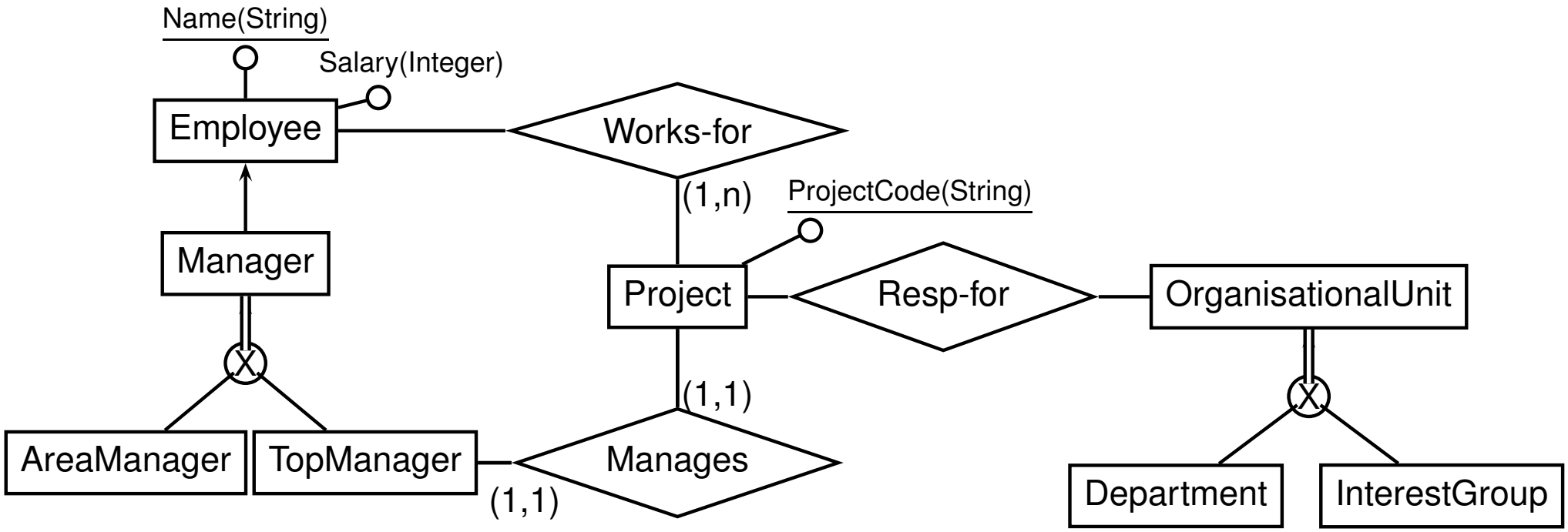
- Sub-entities of temporary entities must be temporary.
- Super-entities of snapshot entities must be snapshot.
- A schema is inconsistent if exactly one of a whole set of snapshot partitioning sub-entities is temporary.

Inference with Timestamps



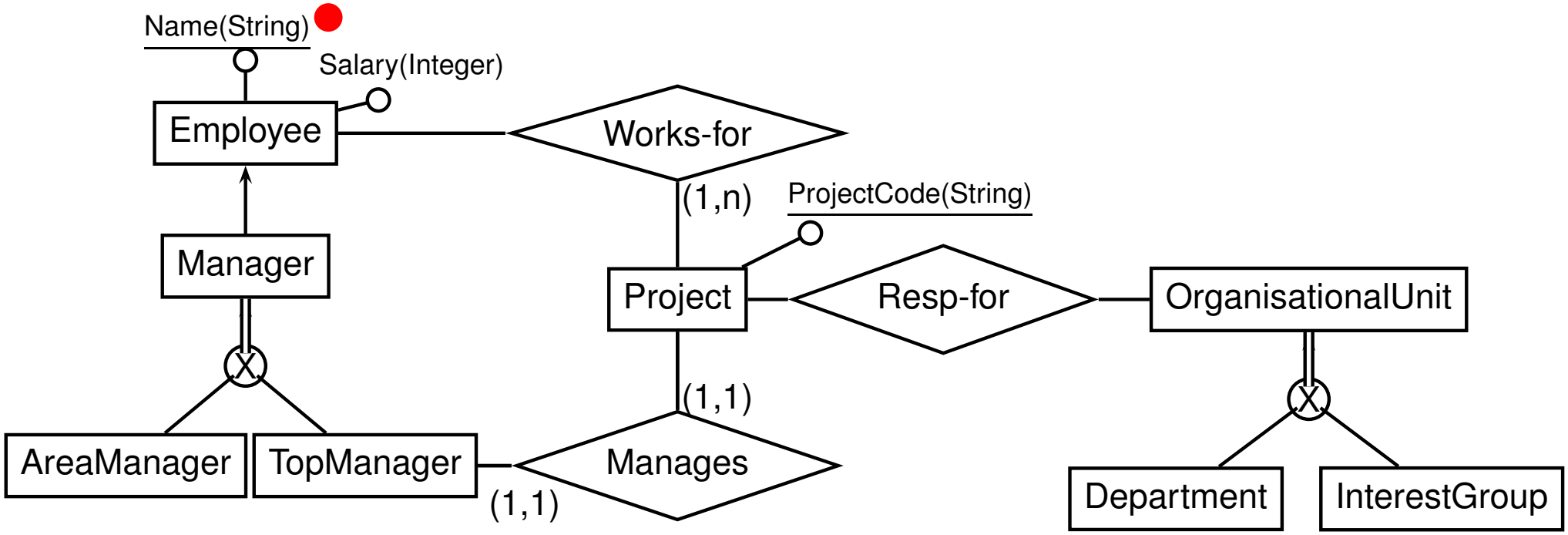
- Sub-entities of temporary entities must be temporary.
- Super-entities of snapshot entities must be snapshot.
- A schema is inconsistent if exactly one of a whole set of snapshot partitioning sub-entities is temporary.
- Participants of snapshot relationships must be snapshot entities.

Timestamping Attributes



- $\texttt{Employee} \sqsubseteq^* \exists^{=1}[\texttt{worker}](\texttt{Name} \sqcap \texttt{nam}/2 : \texttt{String})$
- $\top \sqsubseteq^* \exists^{\leq 1}[\texttt{nam}](\texttt{Name} \sqcap \texttt{worker}/2 : \texttt{Employee})$

Timestamping Attributes



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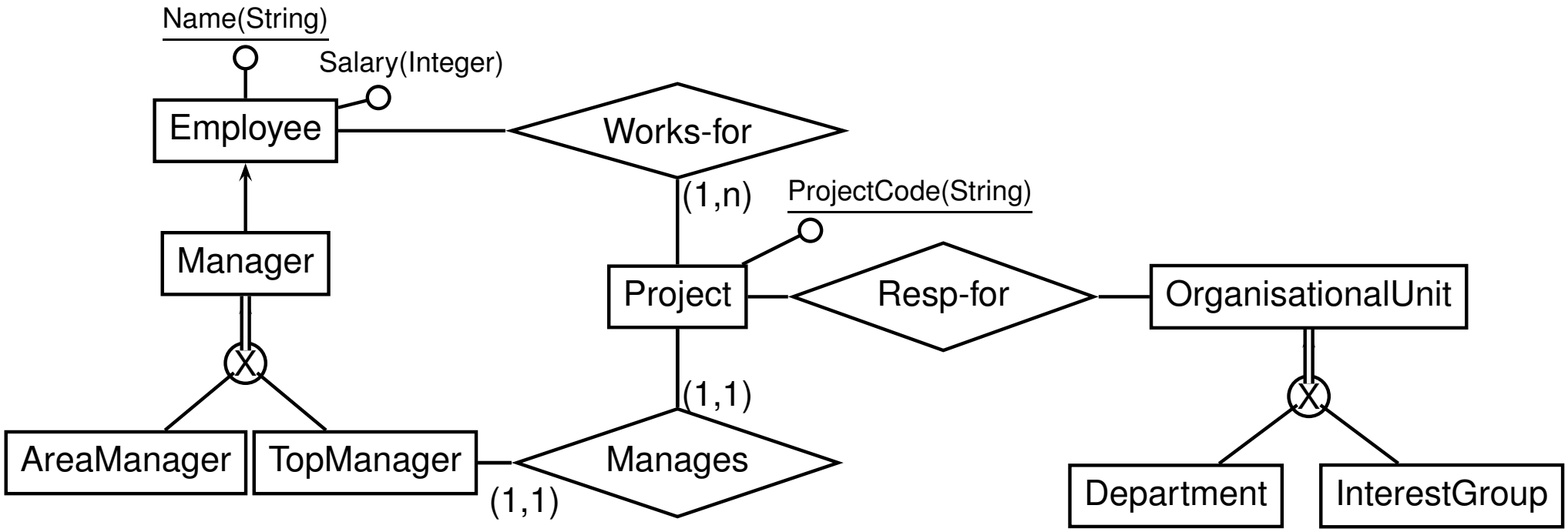
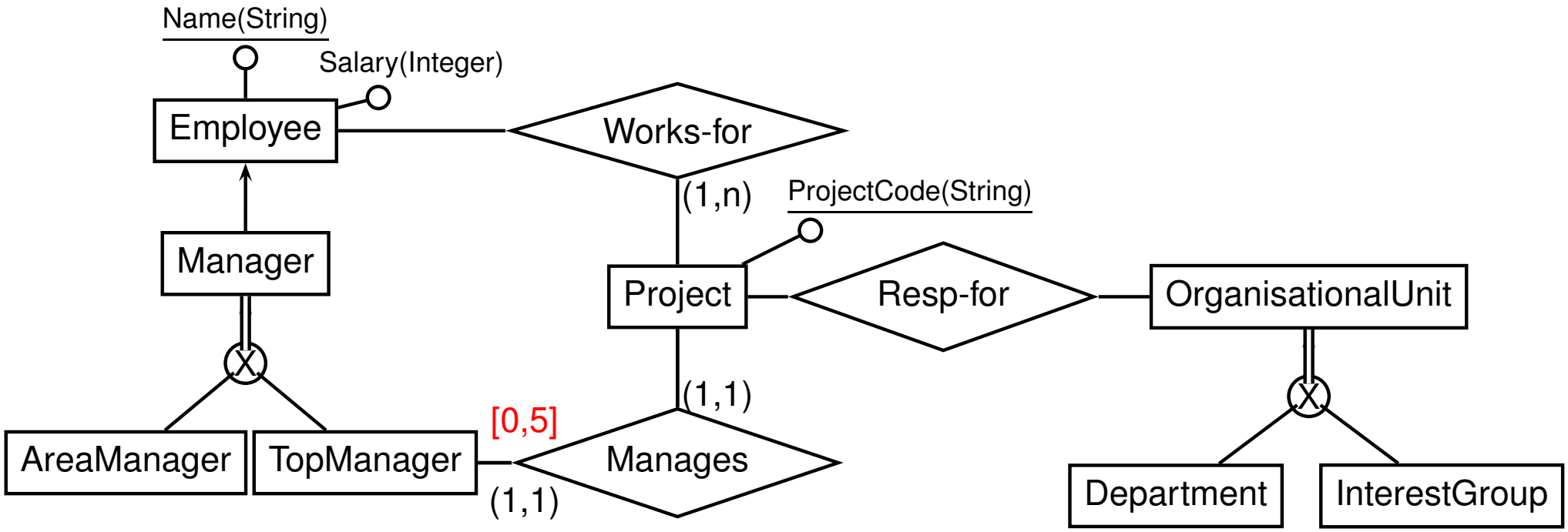
- $\top \sqsubseteq^* \exists^{\leq 1}[\texttt{nam}](\texttt{Name} \sqcap \texttt{worker}/2 : \texttt{Employee})$
- $\texttt{Employee} \sqsubseteq^* \exists^{\geq 1}[\texttt{worker}]\Box^*\texttt{Name}$ *(snapshot attribute)*

Temporal Cardinalities



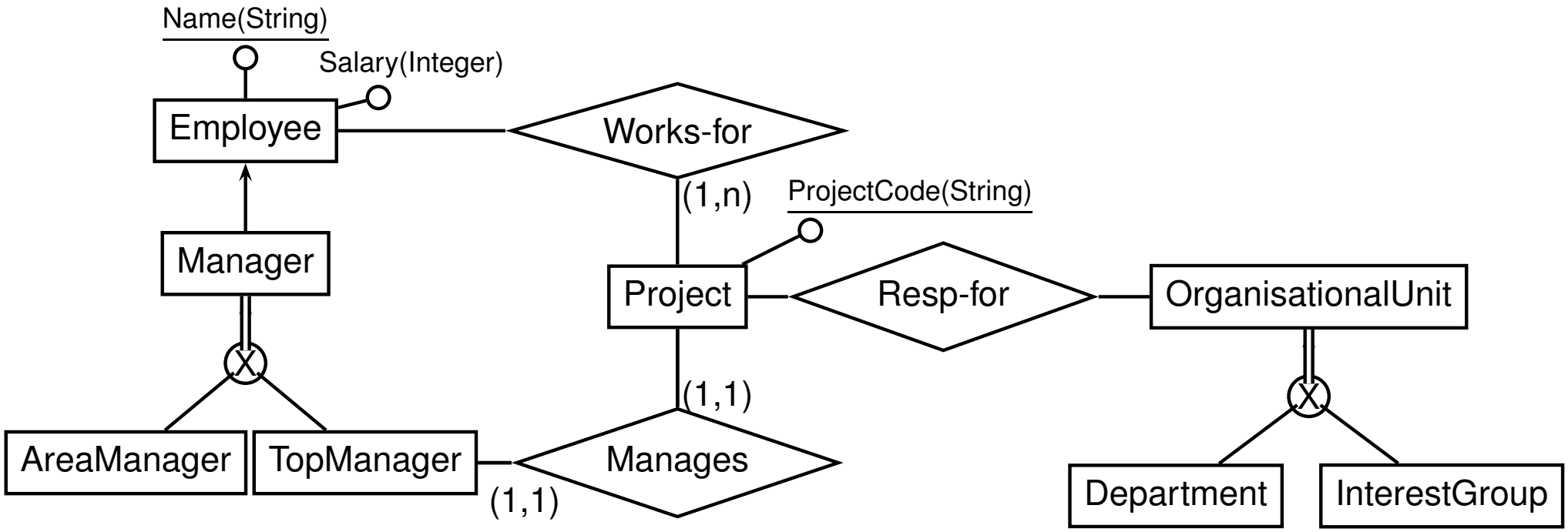
- $\texttt{TopManager} \sqsubseteq^{*} \exists^{=1}[\texttt{man}]\texttt{Manages}$

Temporal Cardinalities

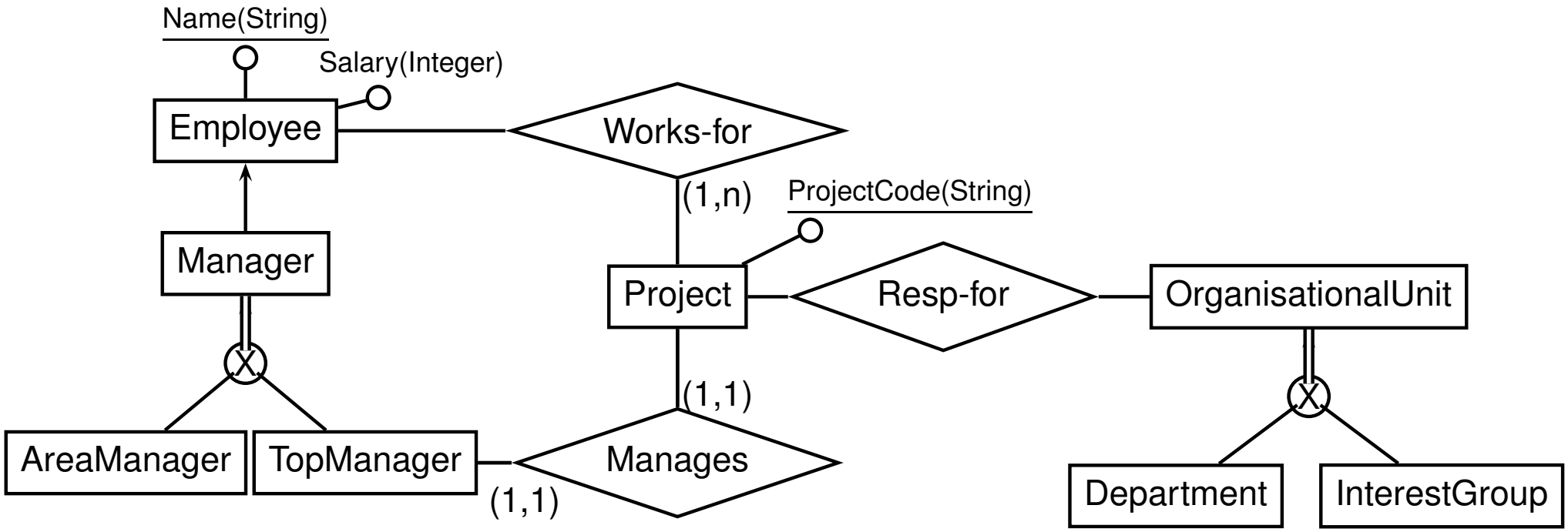


- $\texttt{TopManager} \sqsubseteq^* \exists^{=1}[\texttt{man}]\texttt{Manages}$
- $\texttt{TopManager} \sqsubseteq^* \exists^{\leq 5}[\texttt{man}]\Diamond^*\texttt{Manages}$ *(max. temporal cardinality)*

Dynamic Entities

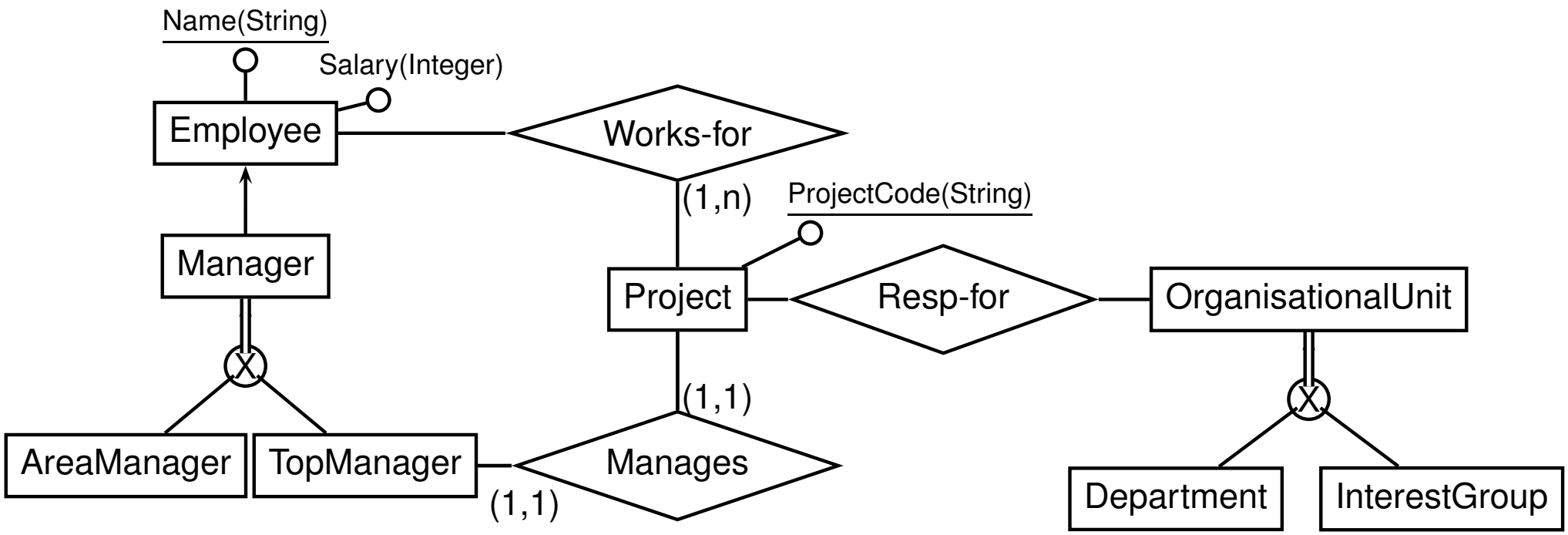


Dynamic Entities



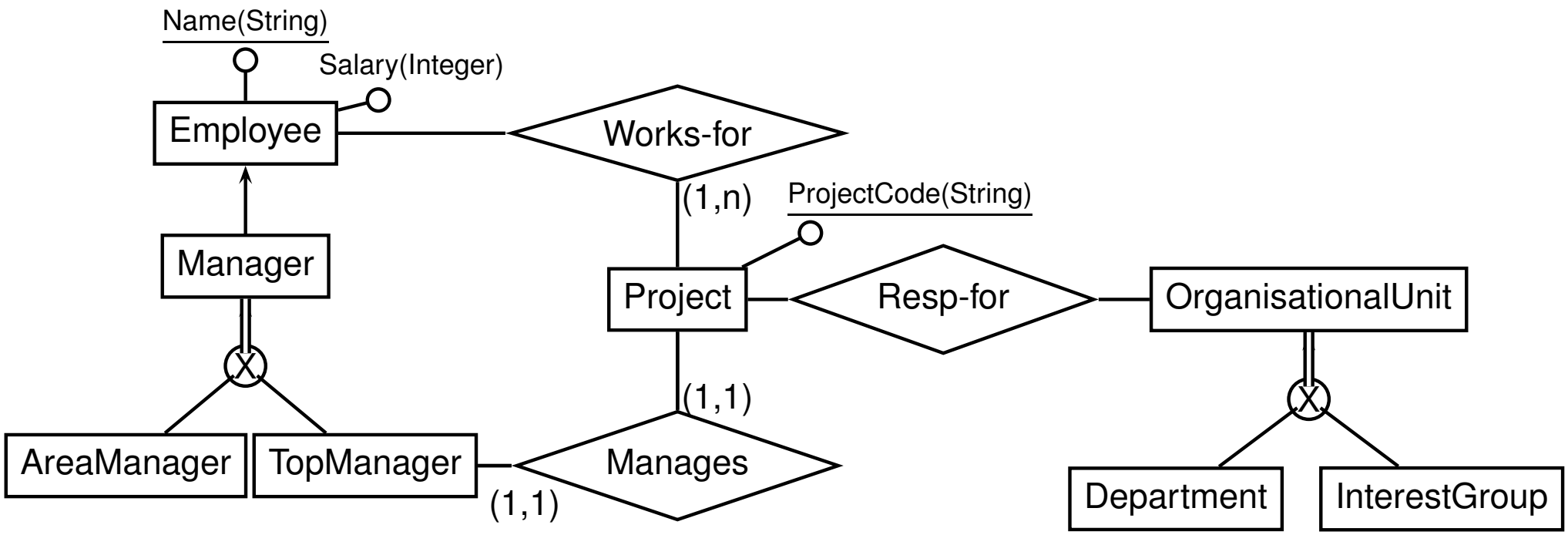
- $\texttt{TopManager} \sqsubseteq^{*} \Diamond^{-}\texttt{AreaManager}$ *(Dynamic Extension)*

Dynamic Entities



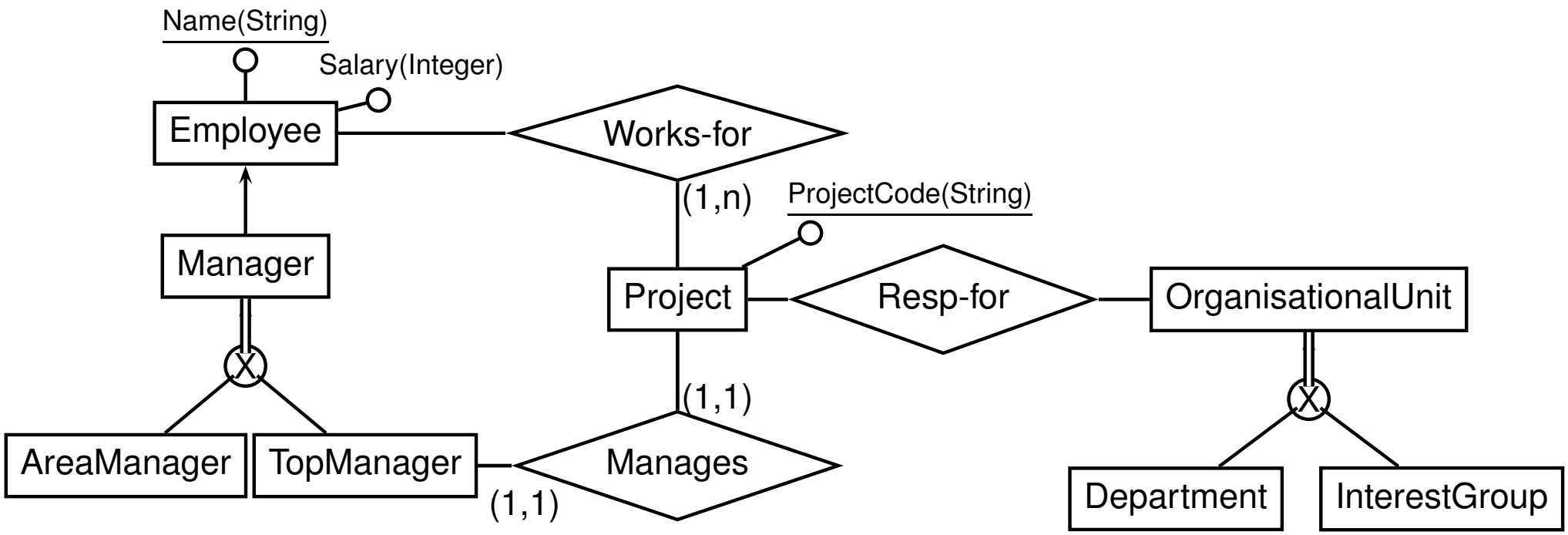
- $\texttt{TopManager} \sqsubseteq^{*} \Diamond^{-}\texttt{AreaManager}$ *(Dynamic Extension)*
- $\texttt{AreaManager} \sqsubseteq^{*} \Box^{-}\neg\texttt{TopManager}$ *(Uni-directional Dynamic Evolution)*

Dynamic Entities



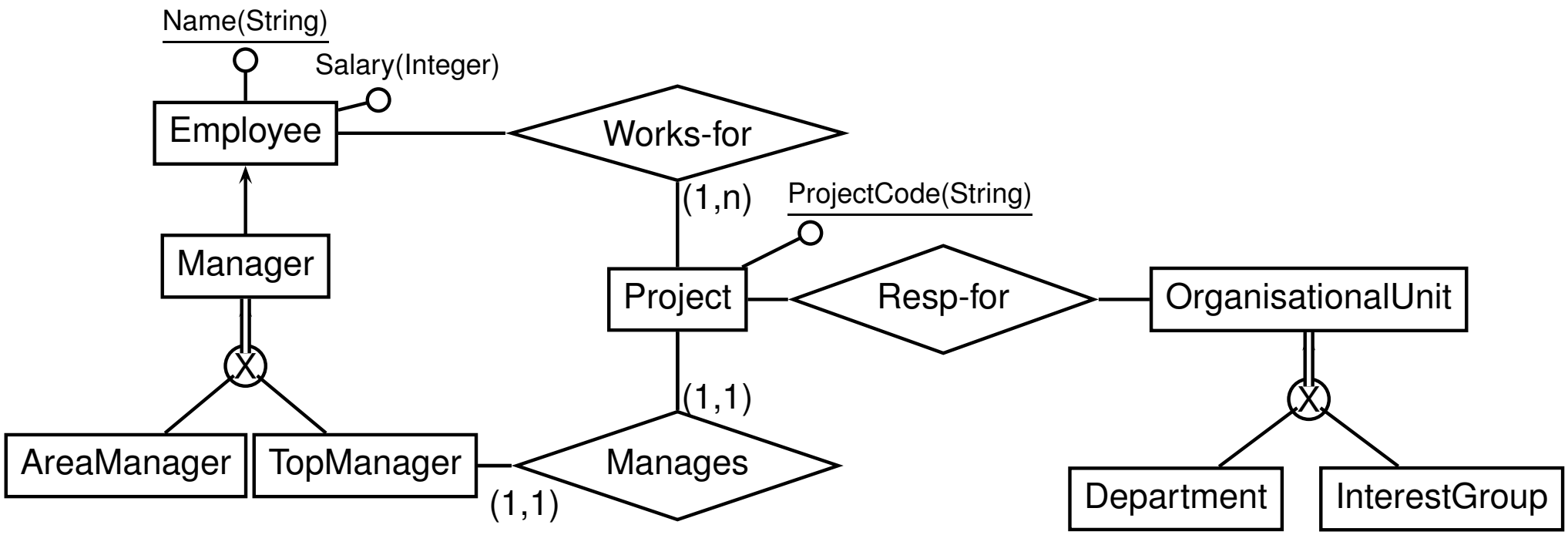
- $\texttt{TopManager} \sqsubseteq^{*} \Diamond^{-}\texttt{AreaManager}$ *(Dynamic Extension)*
- $\texttt{AreaManager} \sqsubseteq^{*} \Box^{-}\neg\texttt{TopManager}$ *(Uni-directional Dynamic Evolution)*
- $\texttt{Department} \sqsubseteq^{*} \Box^{*}\neg\texttt{Interest-Group}$ *(Incompatible Dynamic Entities)*

Dynamic Entities



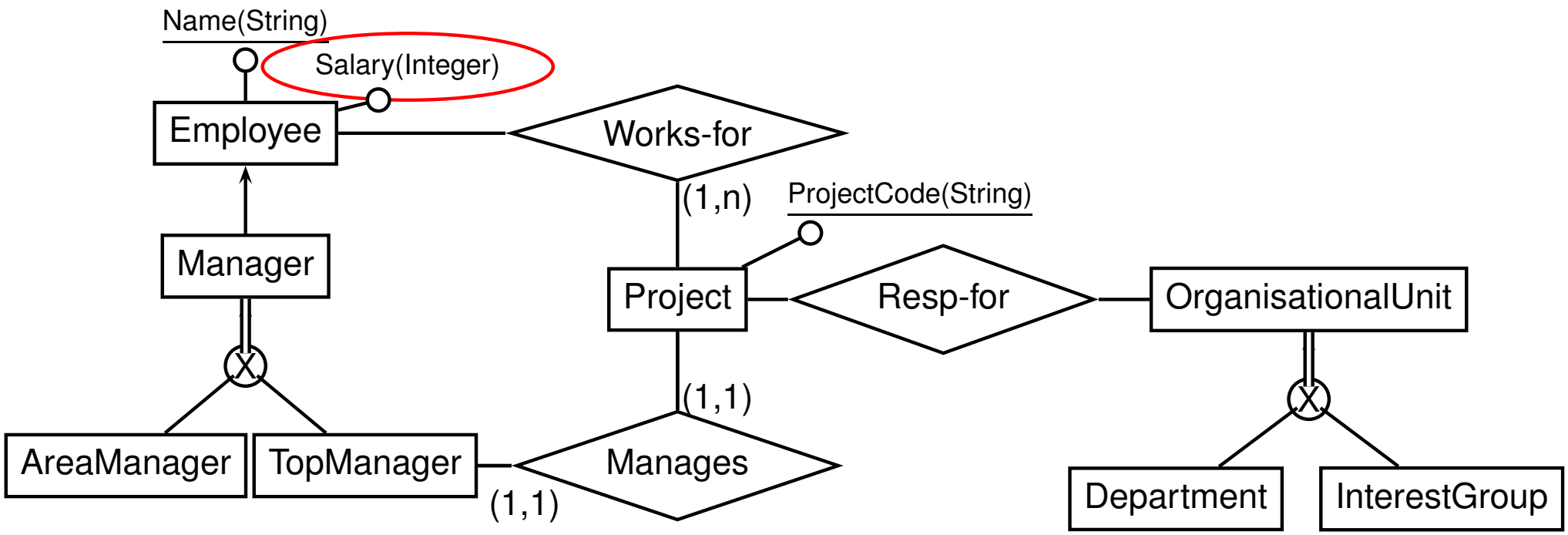
- $\texttt{TopManager} \sqsubseteq^* \Diamond^- \texttt{AreaManager}$ *(Dynamic Extension)*
- $\texttt{AreaManager} \sqsubseteq^* \Box^- \neg \texttt{TopManager}$ *(Uni-directional Dynamic Evolution)*
- $\texttt{Department} \sqsubseteq^* \Box^* \neg \texttt{Interest-Group}$ *(Incompatible Dynamic Entities)*
- $\Box^* \neg (\texttt{Employee} \sqsubseteq \bot)$ *(Global Consistency)*

Schema Evolution



As soon as the organisation does not include interest groups anymore, the salary of top managers should be in the “low amount” class:

Schema Evolution



As soon as the organisation does not include interest groups anymore, the salary of top managers should be in the "low amount" class:

$$\Box^{*}(\neg(\texttt{InterestGroup} \sqsubseteq \bot) \vee \Box^{+}(\exists^{\geq 1}[\texttt{amount}](\texttt{Salary} \sqcap \texttt{payee}/2 : \texttt{TopManager}) \sqsubseteq \texttt{LowAmount}))$$