

Toward an intelligent system architecture for smart agriculture: application to smart beehives

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Context and Motivation



▶ PNAPI

- Main Partners: **EFREI Paris, ITSAP**
- Funder: Ministry of Agriculture and Food through **CASDAR**
- Aim: **Digital Support Platform for Beekeepers**

▶ Framework

- **Decisions** classification
- **Spatial** dimension
- **Temporal** dimension
- To simplify the system **design** process

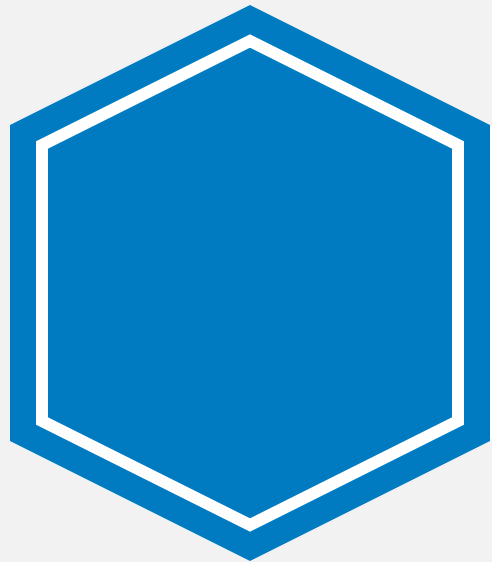




Outline

- ▶ **Digital agriculture and beekeeping**
- ▶ **Analysis with a spatio-temporal Matrix**
- ▶ **Use case on beekeeping domain**
- ▶ **Conclusion and future works**





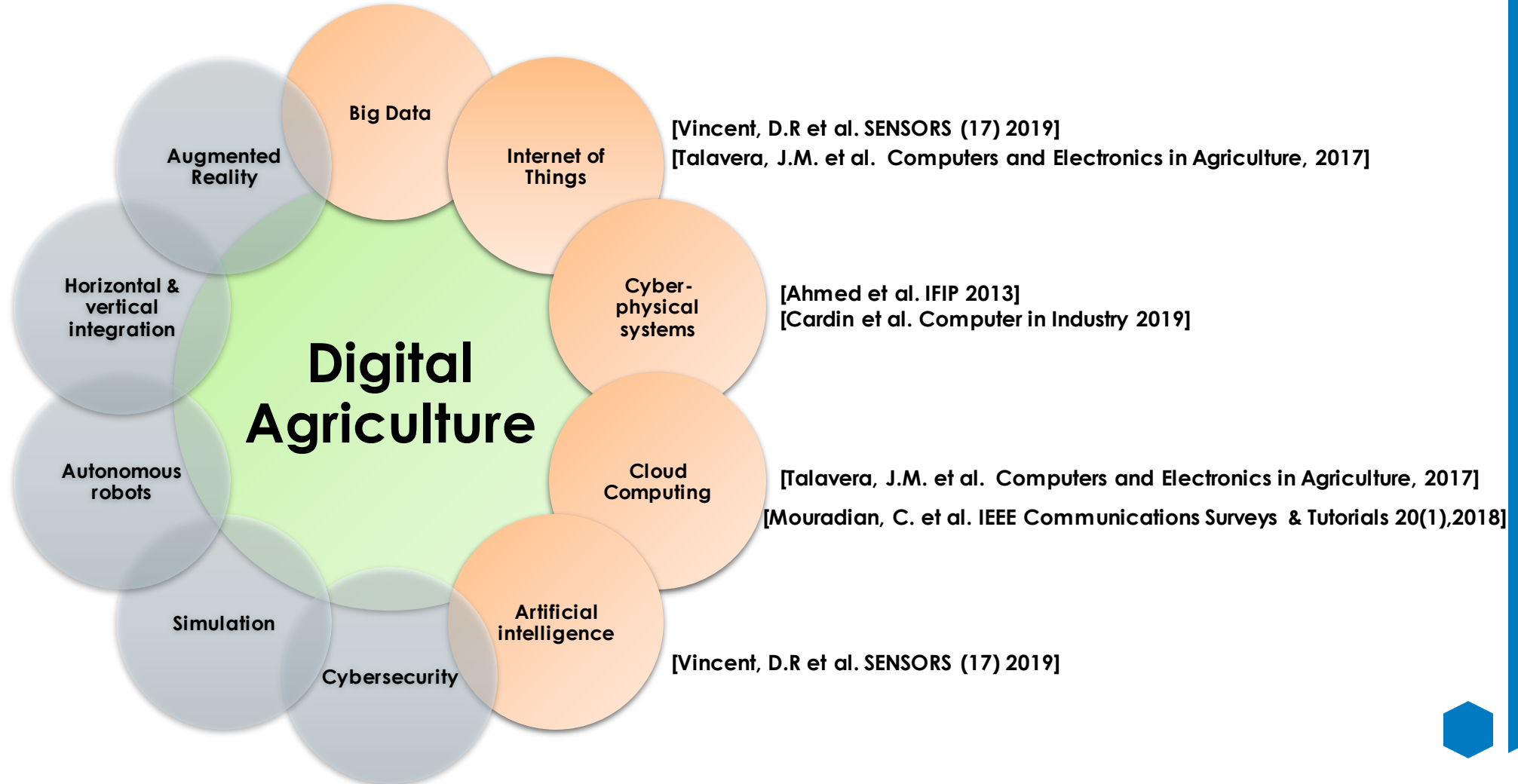
Related Work



Digital agriculture



Reuse of the 10 technologies of Industry 4.0





Digital Beekeeping

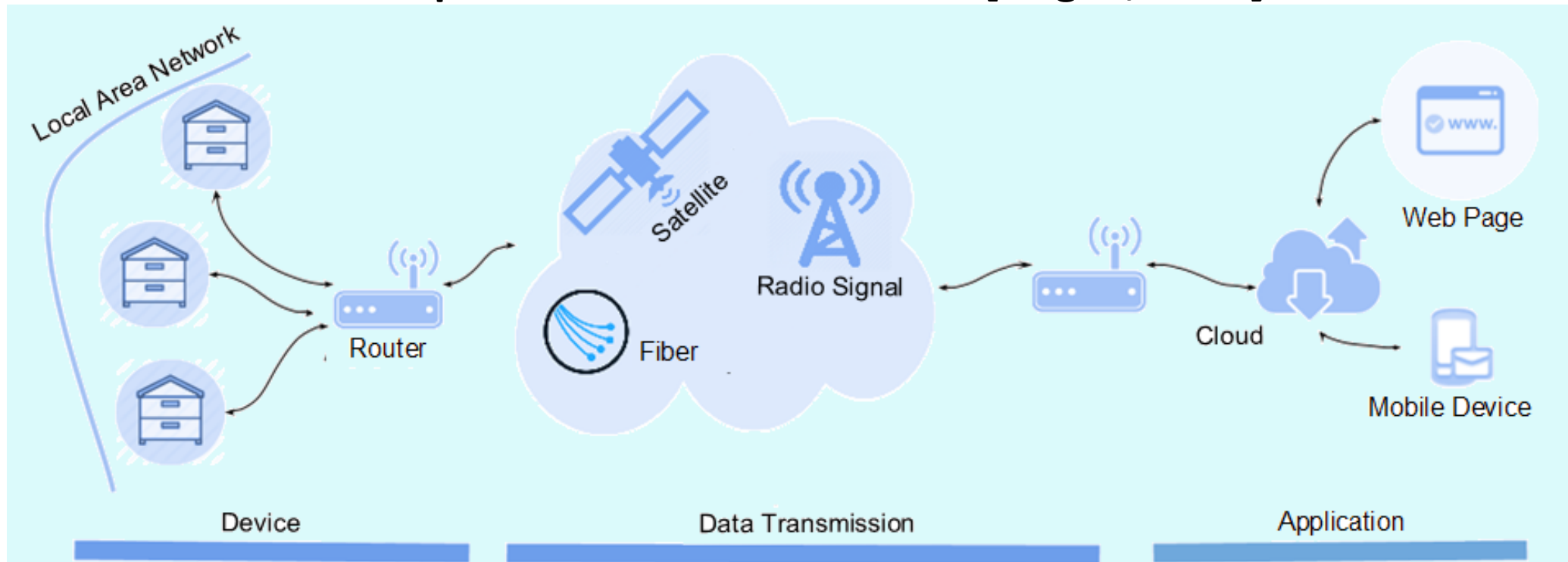
- ▶ **[Dogan et al. International advanced technologies symposium, 2017]**
 - Technical architecture
 - Hive sensors and hardware study
 - Limit: **Microscopic level only**
- ▶ **[Zogovic et al. International Conference on Information Society and Technology, 2017]**
 - Cyber-Physical beekeeping
 - OODA cycle
 - Spatial dimension
 - Limit:
 - **Missing example of decisions**
 - **Missing temporal dimension**
- ▶ Our contribution: **A global framework classifying decisions using spatial and temporal dimensions & An application to beekeeping use case**

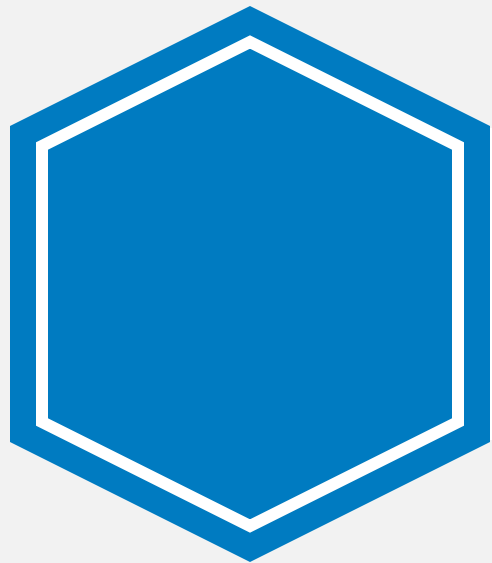


Digital Beekeeping



Example : software architecture [Dogan, 2017]





Analysis with a spatio-temporal Matrix





Spacio-temporal Matrix

- ▶ **Two axis:** the temporal horizon and the modeling level (spatial)

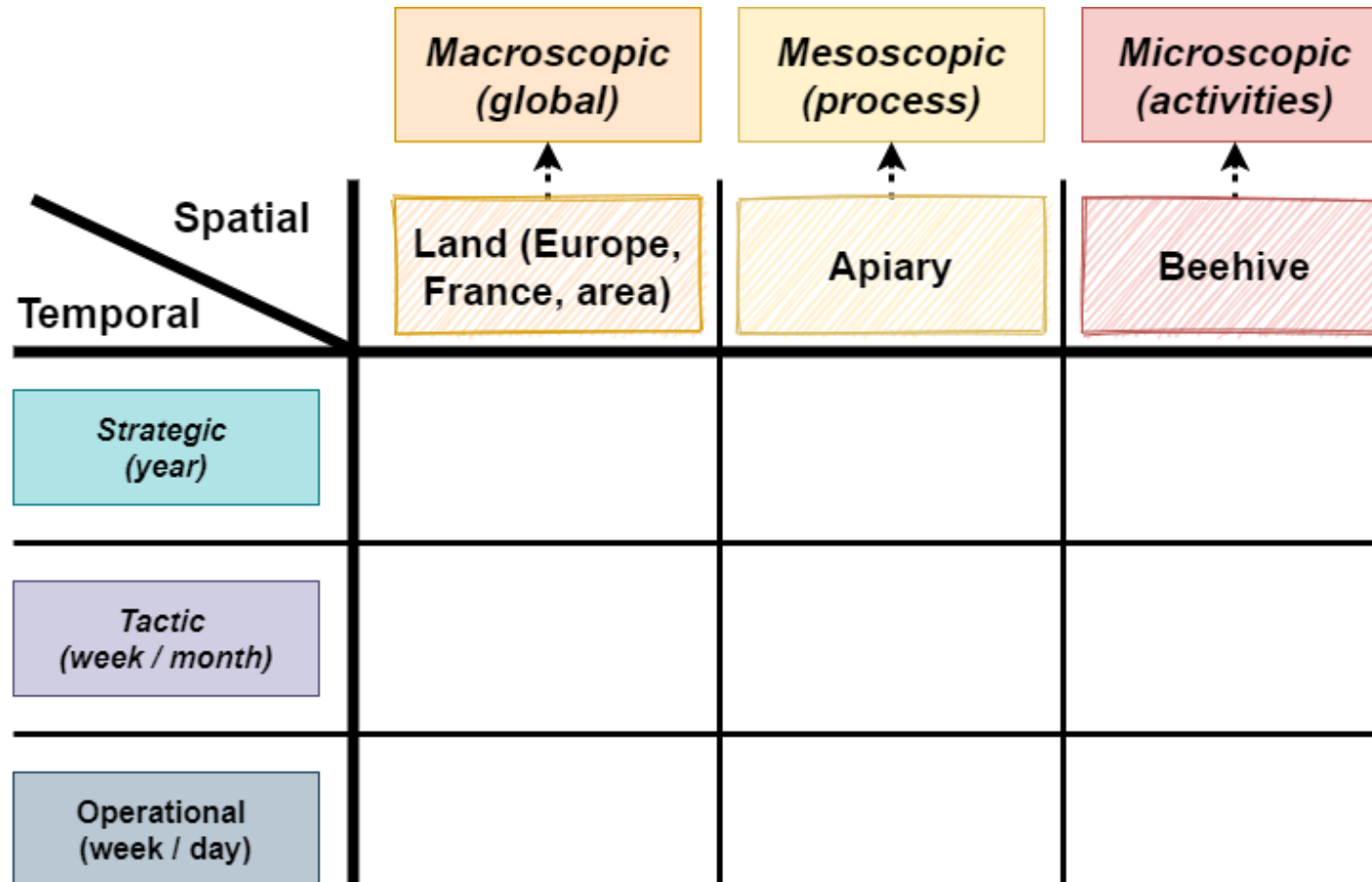
Spatial	Macroscopic (global)	Mesoscopic (process)	Microscopic (activities)
Temporal			
Strategic (year)			
Tactic (week / month)			
Operational (week / day)			

- ▶ Example in the literature:
 - [Comelli et al. 2008]: **supply chain**
 - [Chabrol et al. 2008]: **hospital systems**



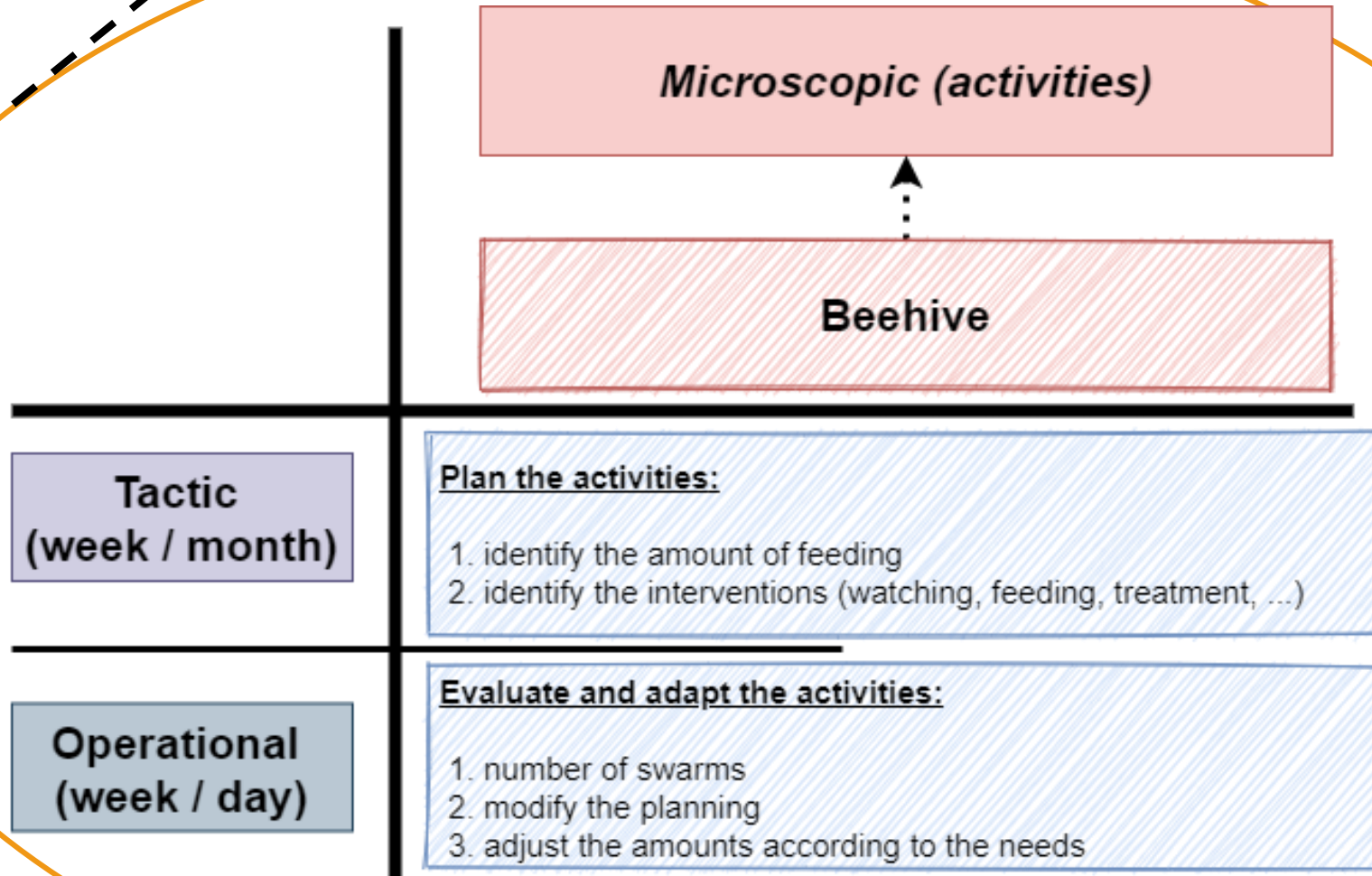
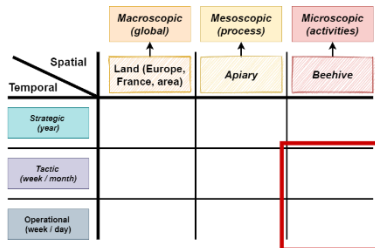
Spacio-temporal Matrix

Use case on beekeeping



Spacio-temporal Matrix

Use case on beekeeping



ApiSoft: purpose-built application for beekeepers



Fiche de suivi

Rucher

Ruche

Date

Avant ouverture de la ruche

Nombre de Hausse

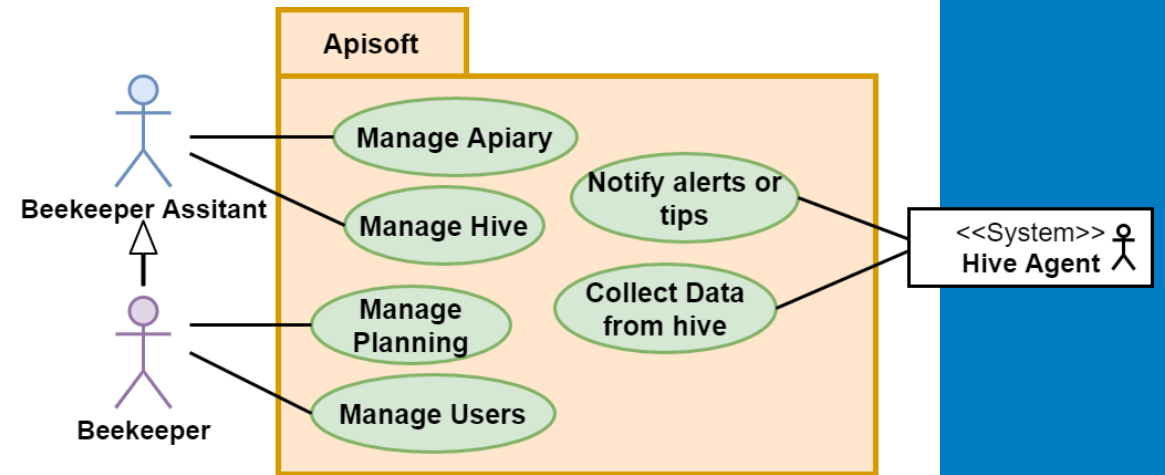
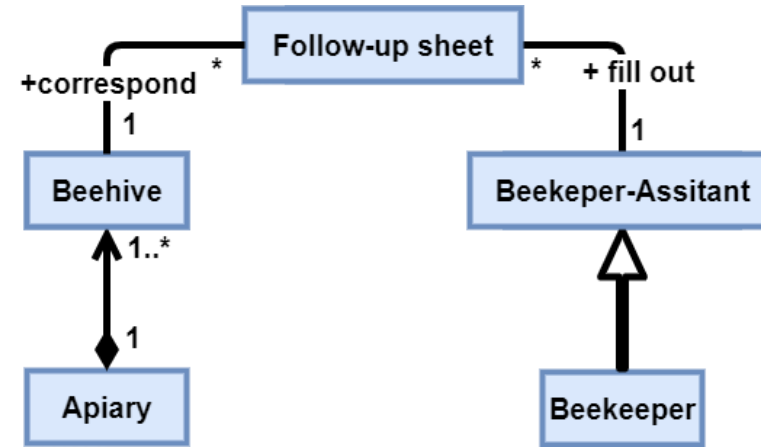
Trafic à l'entrée

Toit en place ?
 Oui Non

Porte d'entrée en place ?
 Oui Non

Après ouverture de la ruche

	Nombre de cadre	Surface occupée (en %)
Couvain	<input type="text" value="0"/>	<input type="text" value="0"/>
Pollen	<input type="text" value="0"/>	<input type="text" value="0"/>
Miel	<input type="text" value="0"/>	<input type="text" value="0"/>
Hausses occupées	<input type="text" value="0"/>	
Attitude des Abeilles	<input type="text" value="Douce"/>	



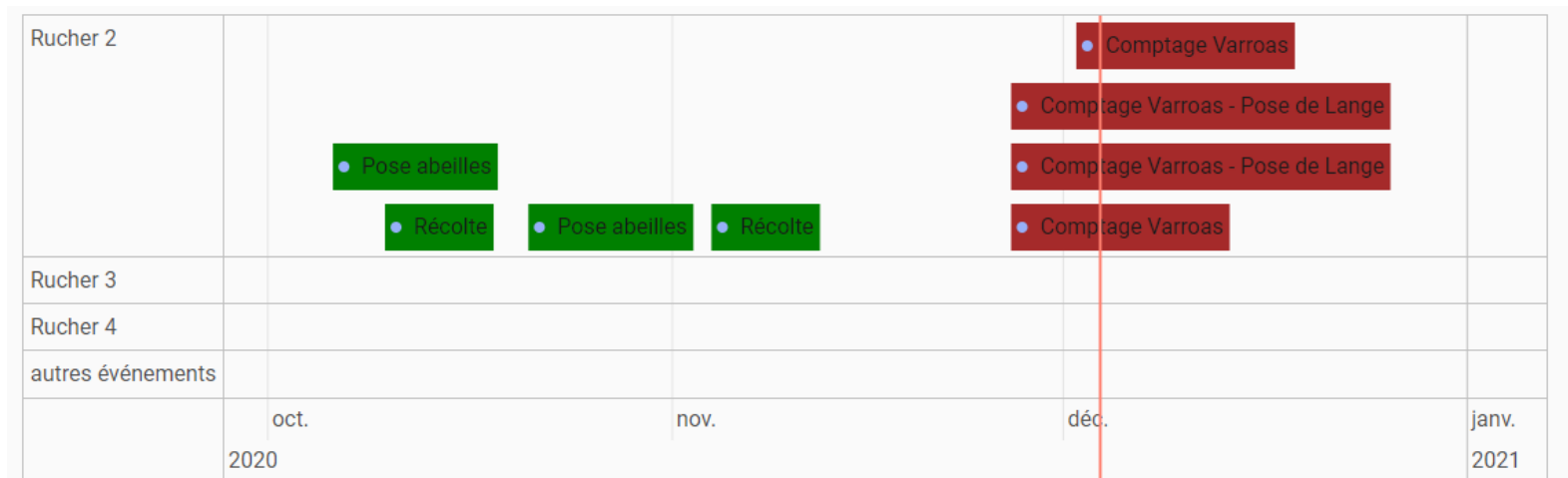


ApiSoft: purpose-built application for beekeepers

Sélectionner un Rucher: Sélectionner une ruche

	n° ruche	nbr Hausses	nbr Hausses après	Traffic	Attitude	Reine	population	symptomes	traitement
1	1	8	7	moyen	Douces	Bleu	Normal	trop de varoa	RAS
2	1	5	5	élevé	Douces	Jaune	trops d'abeilles	Hausse noir	RAS
3	2	5	4	moyen	Agressives	Non marquée	Normal	Hausses noires	RAS

→ Updating of the planning of the beekeepers





Conclusion and future works

▶ **The added value of the Matrix**

- Allows to organize the different kinds of decisions using the time and geographical horizons
- First step toward a global methodology

▶ **Methodology strengths**

- Digitalization of beekeeping
- Digitalization of the agriculture
- Based on the recent works about Industry 4.0 and fog computing (Edge Computing)

▶ **Future works:** Continue to develop different utilization of the spacio-temporal matrix in collaboration with the Technical and Scientific Institute of Beekeeping and Pollination



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