Sensor Based Risk Assessment for Dangerous Products Supply

Dr. Laurent Gomez, SAP Research

Sixth International Conference on Sensor Technologies and Applications
WSNSCM 2012
August 19 - 24, 2012 - Rome, Italy

RESCUEIT

secuREd ServiCe enabled sUpply chain connEctivity from the real world up to the world of IT

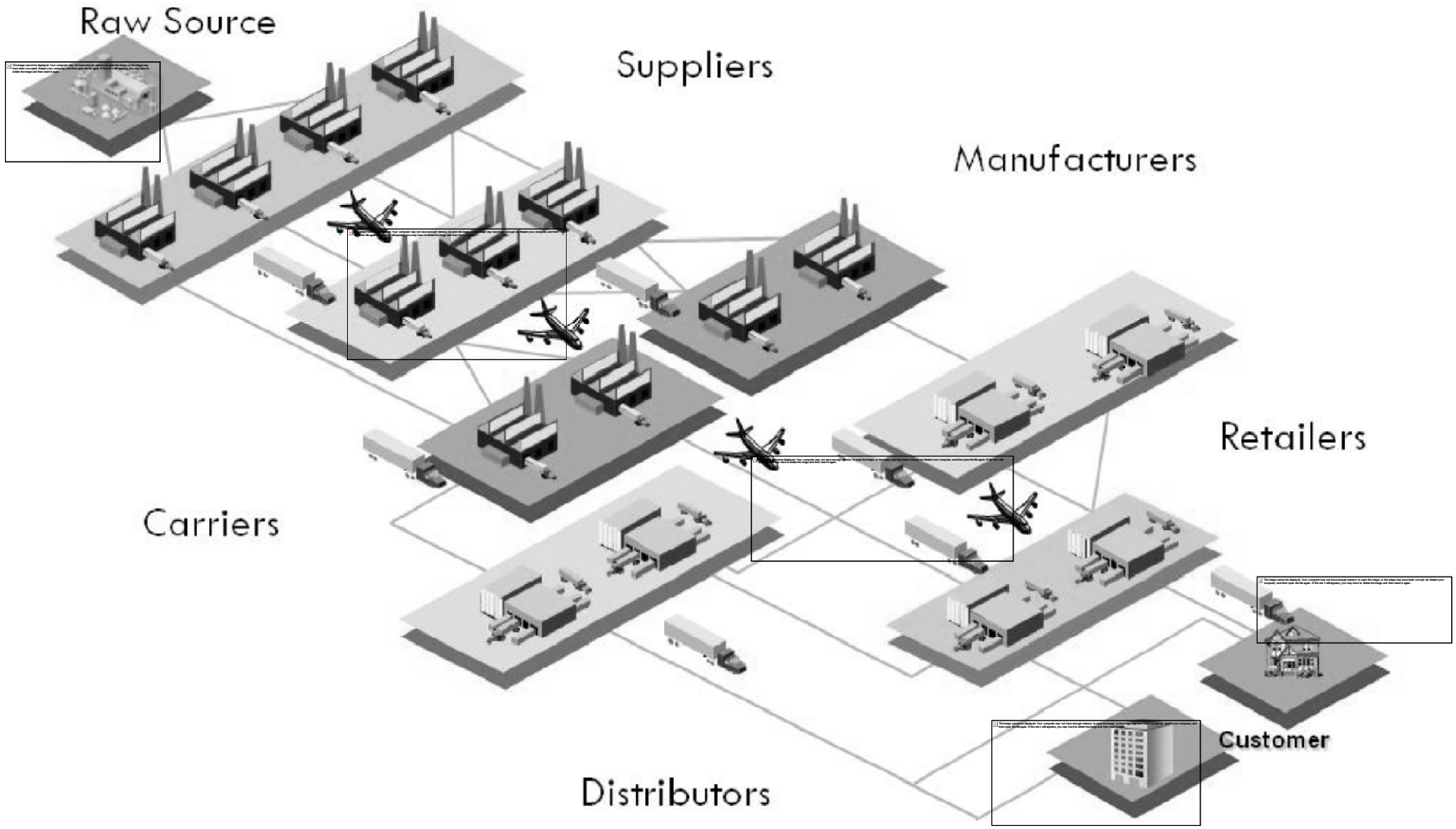
1st ever German-French research project **in Public Security**

Leverage German French research funding

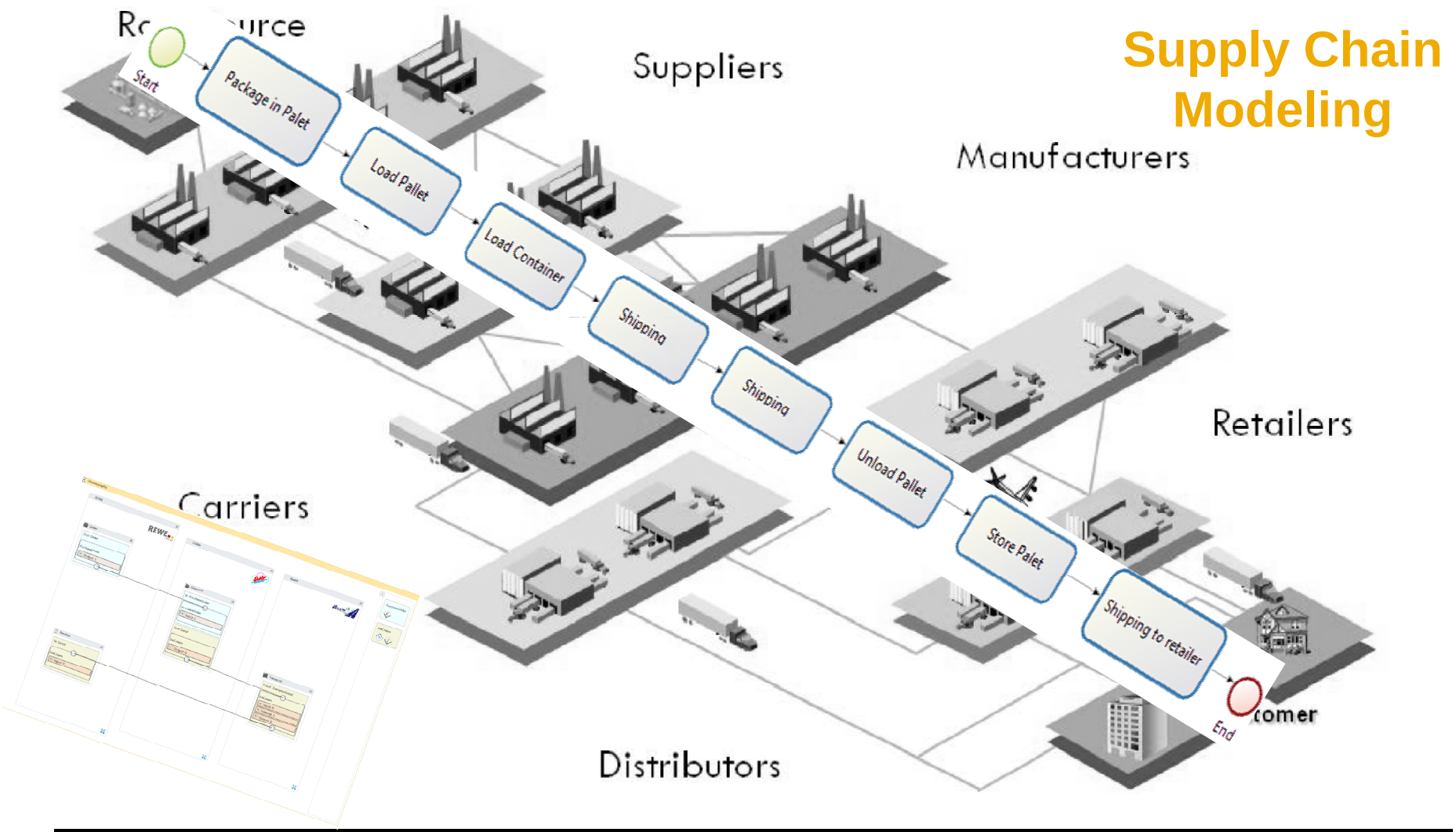
German-French Research Project, funded by **BMBF / ANR** in the context of the “Securing the Supply Chains / “Concepts Systems and Tools for Global Security” call.

Involves major actors of the supply chain

RESCUEIT in a Nutshell



RESCUEIT in a Nutshell



Scenario
Importation of dangerous products to Europe

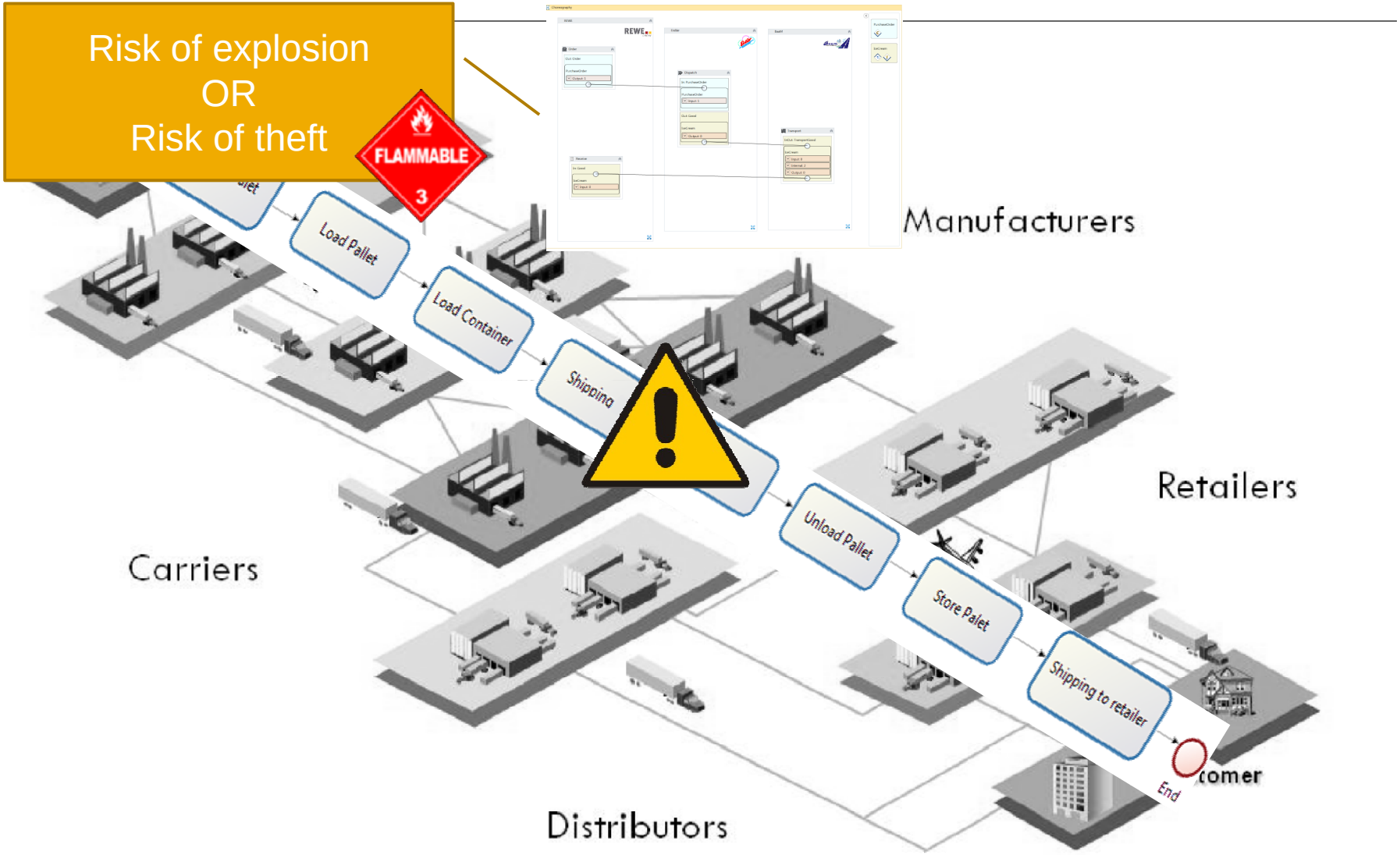
Dangerous products are imported from China;

Products are shipped by boat to Le Havre harbor;

After customs check, products are shipped to a K+N warehouse;

Products are shipped by truck to the retailer storage units

RESCUEIT in a Nutshell



Products identified as dangerous products
stored in K+N warehouse classified SEVESO II

Detergent - ICPE 1412

Harmful and polluting liquids

Flash point 66 celsius degrees

Must not be mixed with acid, bases or oxidizing

Risk of fire, if exposed to high temperature

Aerosol – ICPE 1432

Restricted quantity in a single location

Flash point 13 celsius degrees

Muts not be in contact with metal and acids

Risk of fire, if exposed to high temperature

Impact on the population and environment

Fire

Merchandises and packaging highly inflammable

Toxic gas emission

Lethal consequence on individuals

Under the effect of heat, emission of hydro-cyanic acid or oxides of sulphur.

Dispersion of extinction waters

Containing water plus chemical, foam, powder

May pollute surface or underground waters.

Food contamination

Compliance with dangerous products regulation

Regulation compliance along the supply chain

Manipulation, shipping, storage of dangerous products

"In order to ensure compliance with the safety regulations, shipped goods have to be identified together with their classification (e.g. flammable, explosive)."

European Chemicals Regulation

REACH (Regulatory framework for the management of chemicals)

At the French level

ICPE (« Installation Classes pour la Protection de l'Environnement »).

Units classified as SEVESO I/II for the storage of dangerous goods.

Problem

All the supply chain actors are not subject to the same regulations

Because they are not at the same location

Chinese regulation vs European regulations vs boat shippment regulations

Because they are subject to the same classification

K+N warehouse has to be classified SEVESO II in order to store chemical

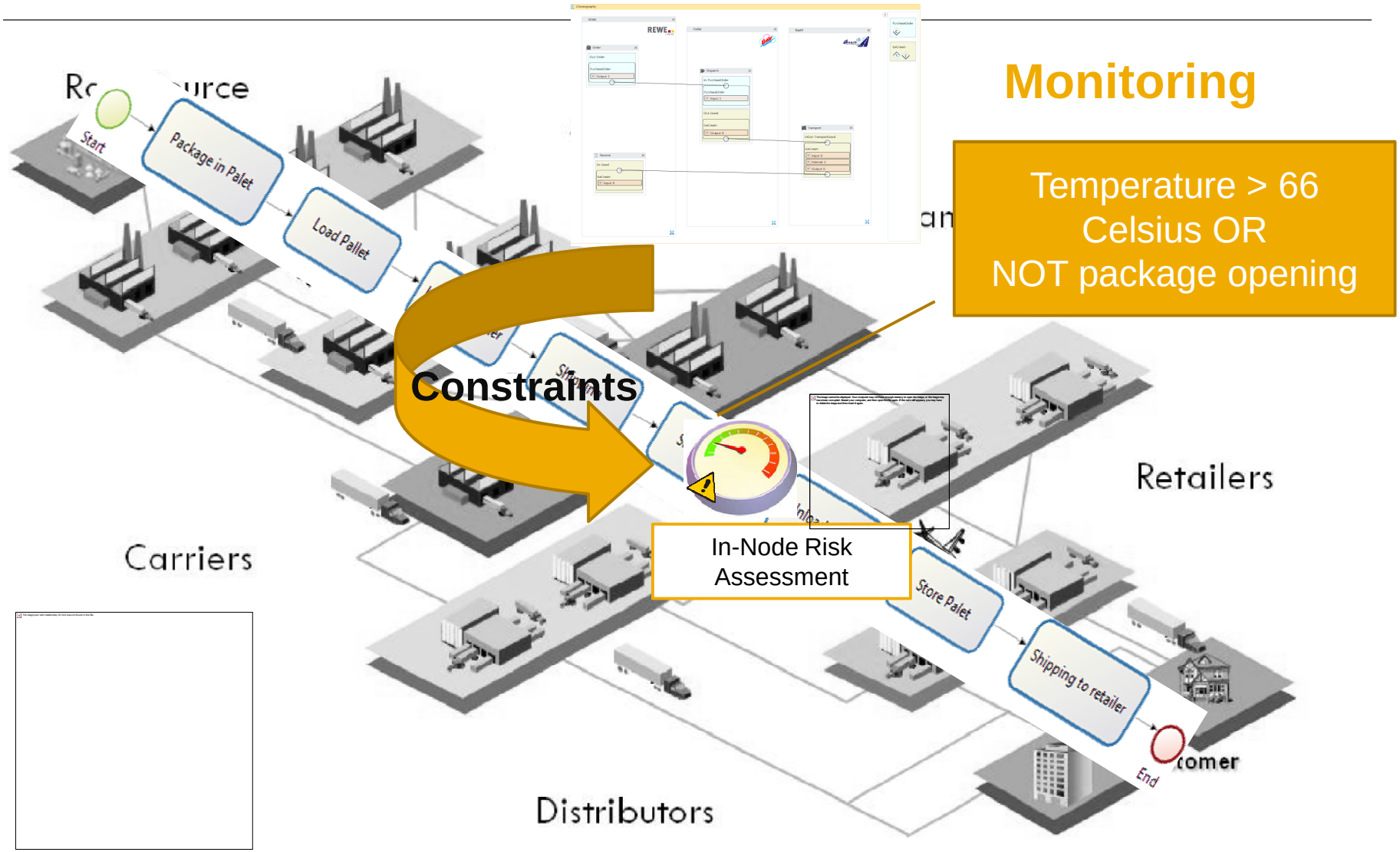
Retailer warehouse has no specific storage constraints

Risk of food contamination with leakage of liquid detergent

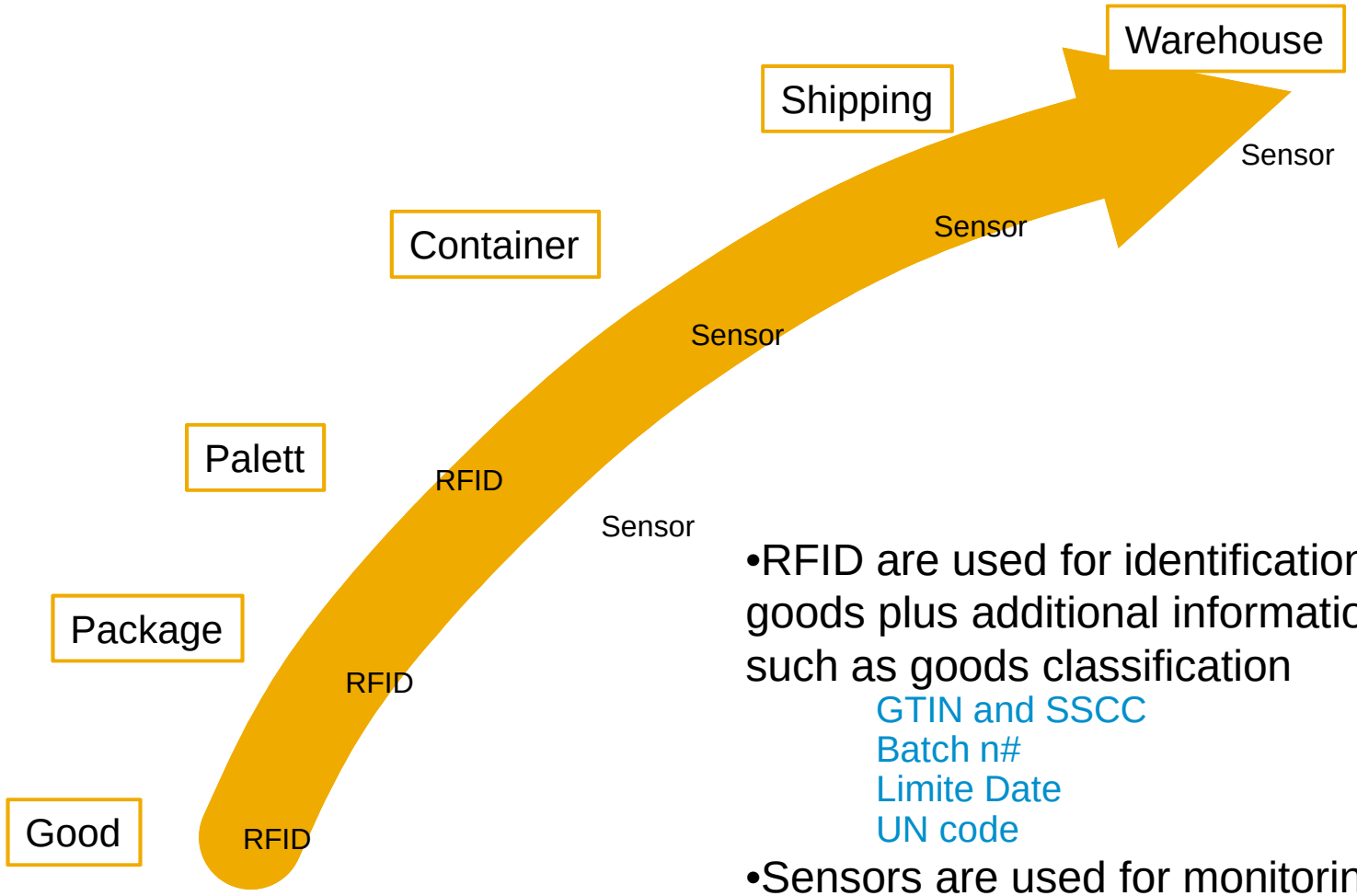
There is no overall risk assessment at the execution of the supply chain

How to evaluate risk at the execution of the supply chain process without any disruption?

RESCUEIT in a Nutshell



Delegation of risk assessment to Sensor



- RFID are used for identification of goods plus additional information such as goods classification
  - GTIN and SSCC
  - Batch n#
  - Limite Date
  - UN code
- Sensors are used for monitoring the supply chain, and risk identification

Identified constraints

Identification of constraints per good classification

ICPE 1172 - squashing, overturn, container opening, liquid leakage

ICPE 1412 – overheating (13ºC), squashing, overturn, container opening

ICPE 1432 - overheating (66ºC), squashing, overturn, container opening

Container opening

Light monitoring

Secure lock

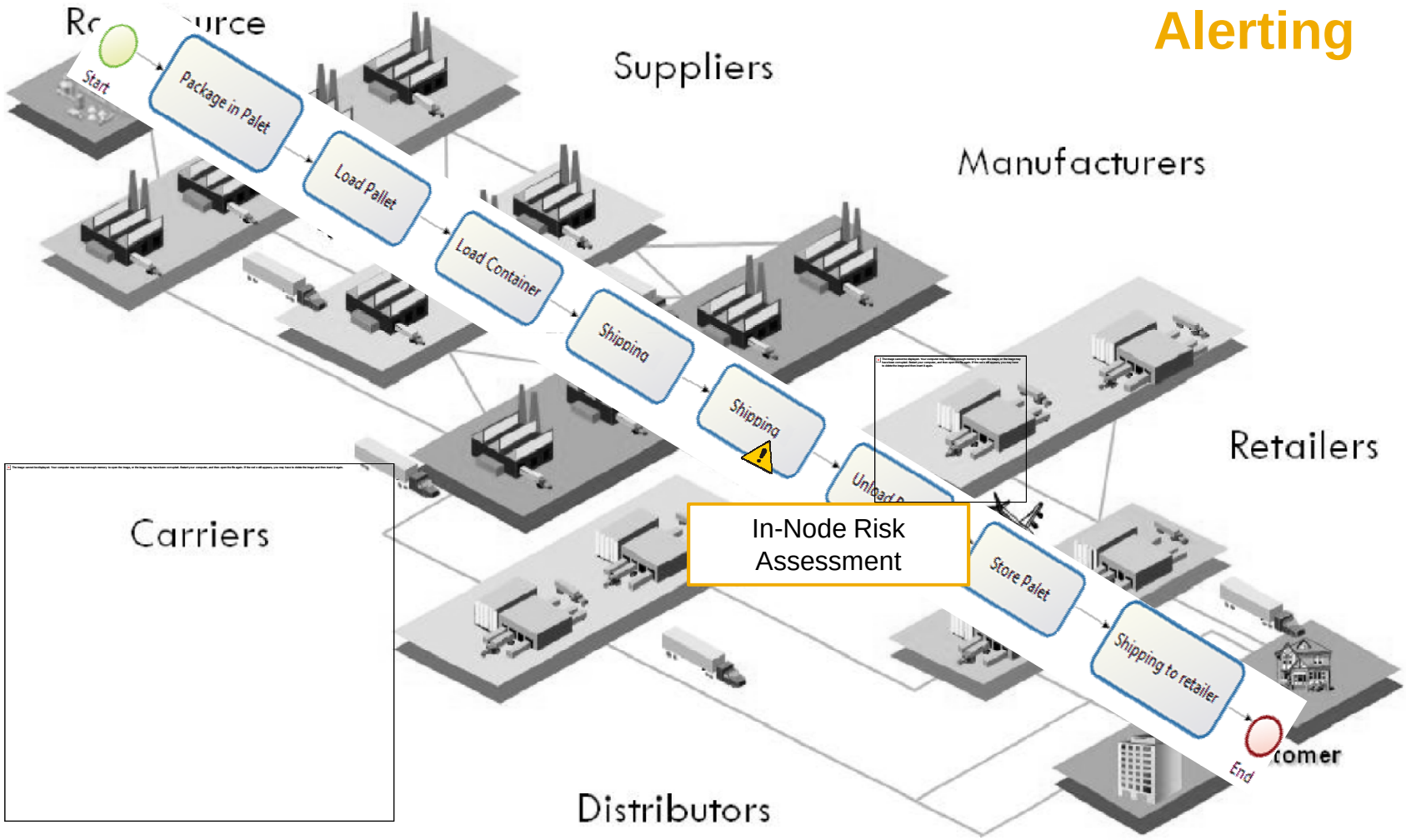
Squashing/overturn

Acceleration pattern

Liquid leakage

Detection of packaging opening, or shock on the products

RESCUEIT in a Nutshell



Terminology

Roadmap

Constraint Extraction

Based on regulations

Flash point

Stability

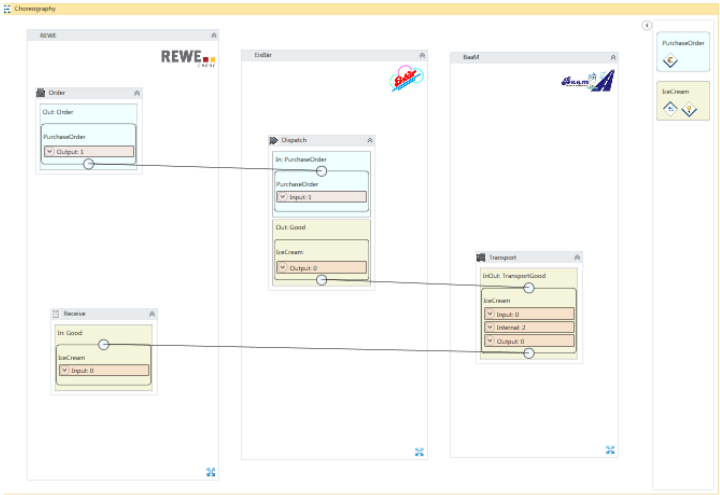
Container/packaging opening

Humidity constraints

Incompatibility between products

Limited of quantity of product stored at the same location

Liquid leakage



Constraint Extraction

Based on activity of the assets

Storage, Manipulation, Shipping

Based on geo localization

EU, Asia

K+N warehouse, retailer warehouse

Constraint Distribution on Nodes

Set of Constraint to be uploaded on sensor nodes

node identifier, constraint identifier,

Type of sensor data, Operation, Threshold

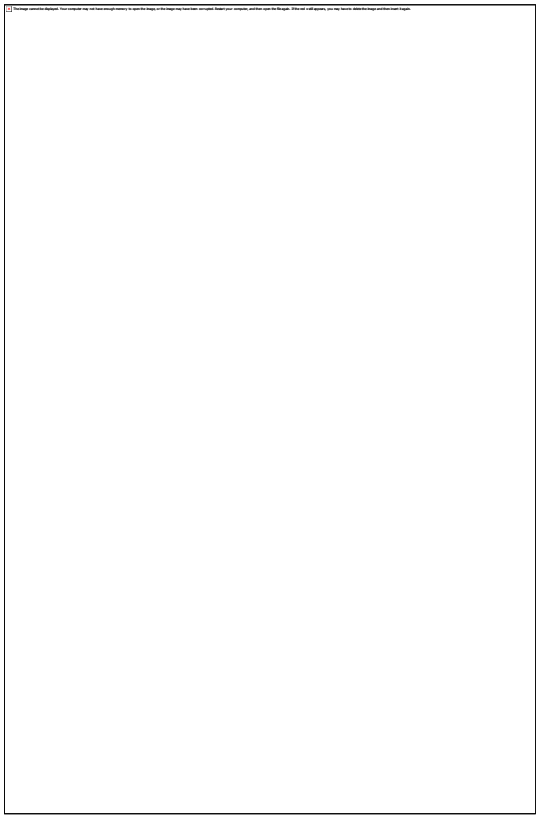
"TEMPERATURE on Node 21 > 27 Celsius."

Byte-code upload

Enablement of combination of constraints

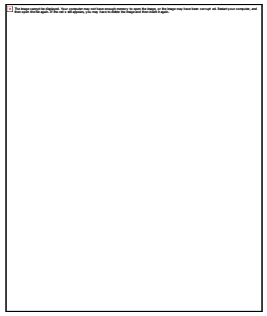
"TEMPERATURE on Node 21 > 27 Celsius." AND

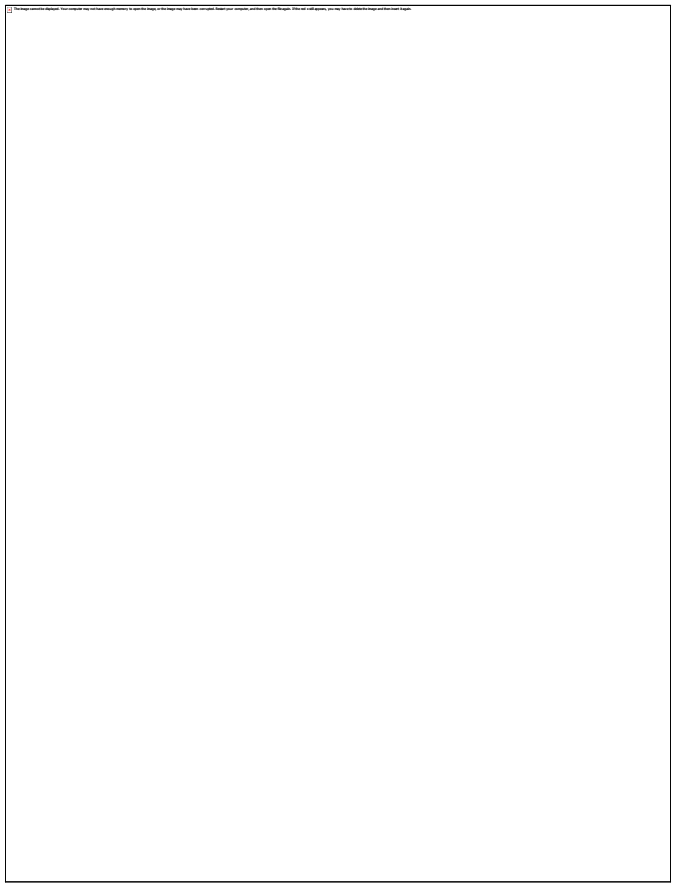
"LIGHT on Node 21 > 400 Lux."



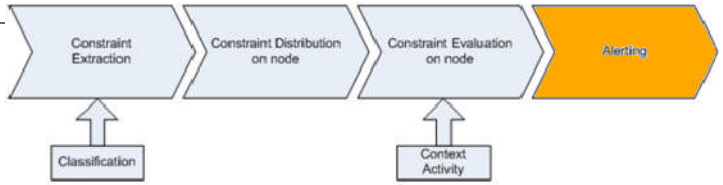
Constraint Evaluation on Nodes

Execution of constraint byte-code



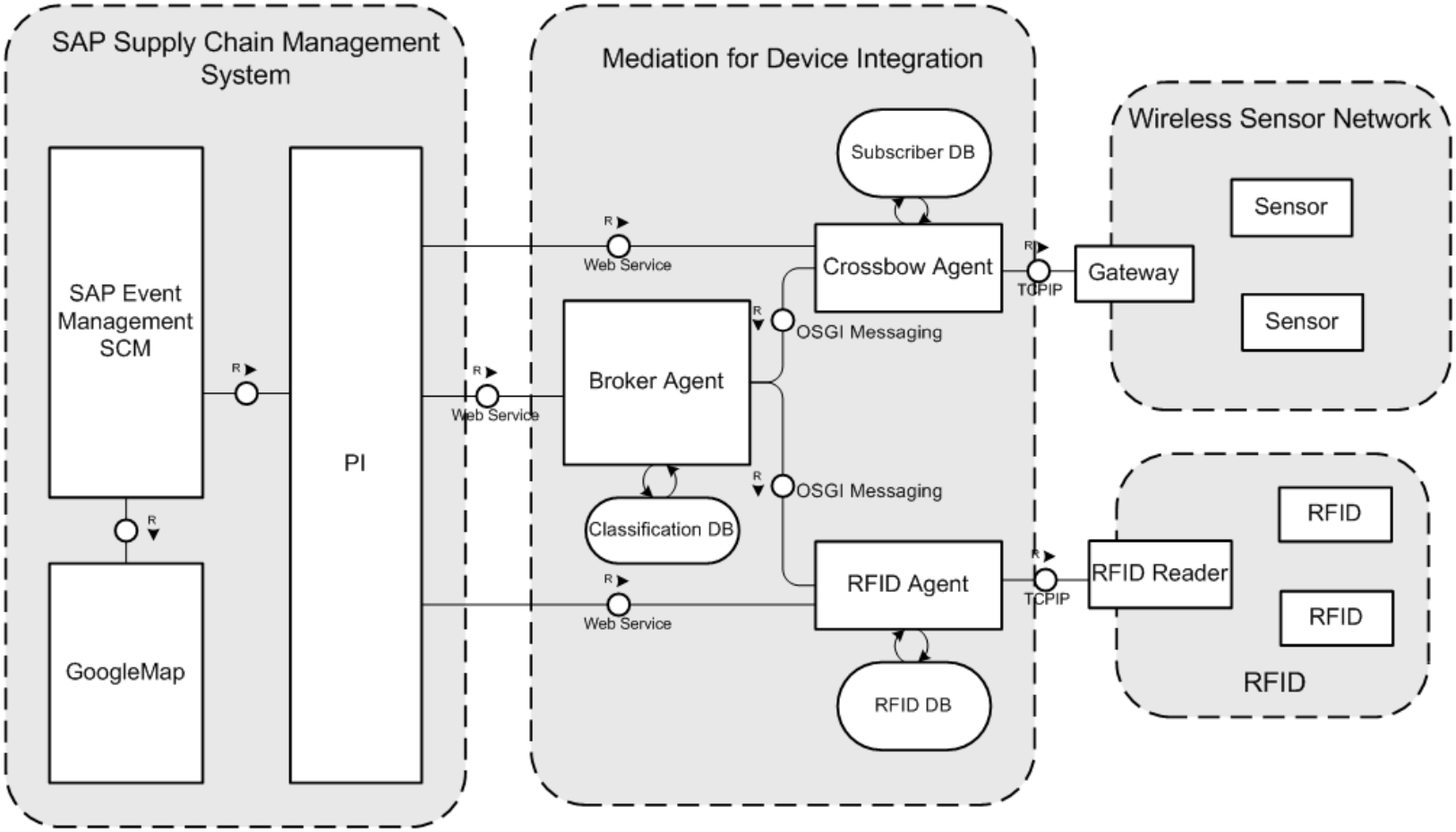


Alerting

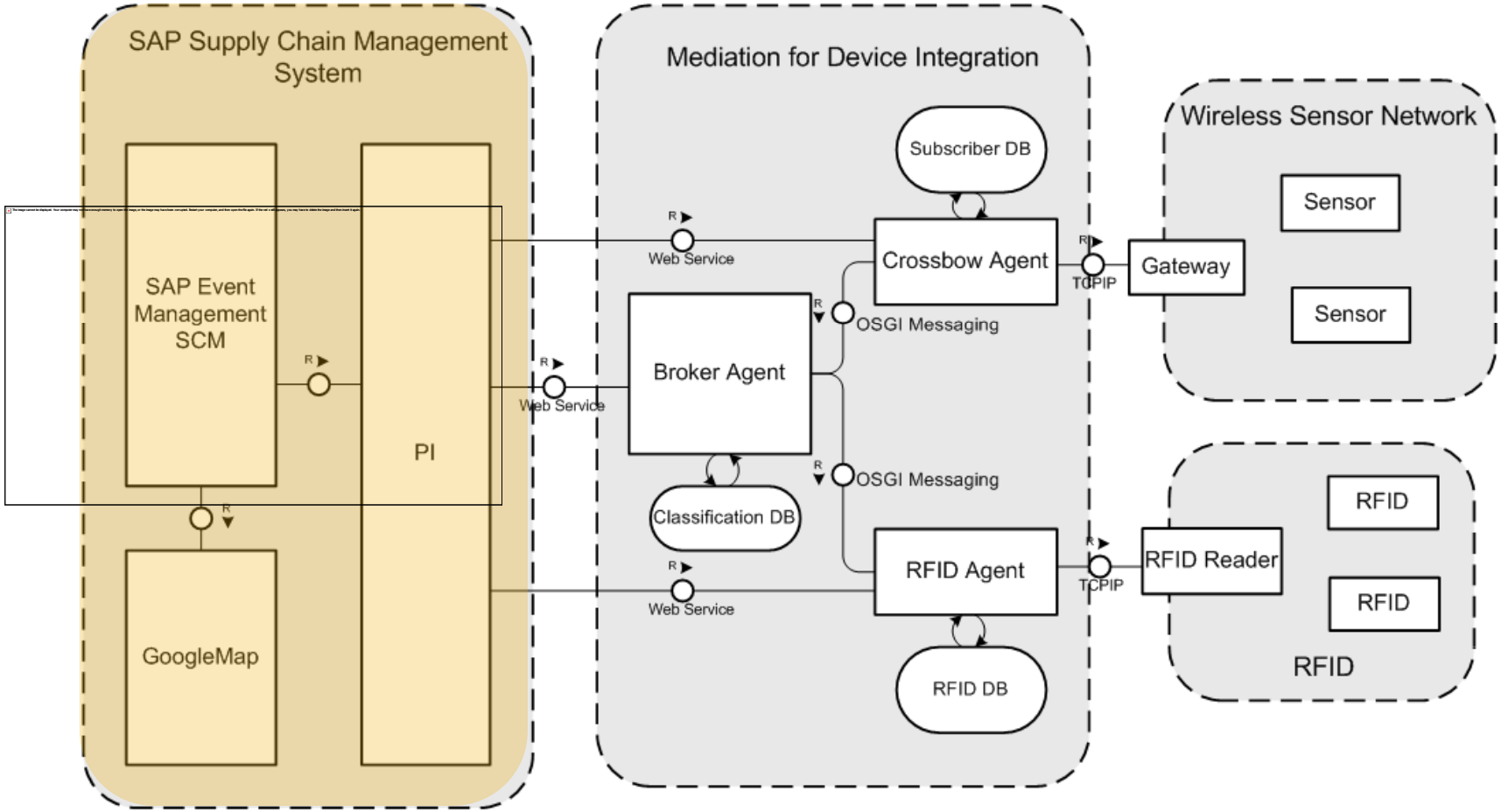


Whenever constraint byte-code detects any constraint violation, an alert is triggered.

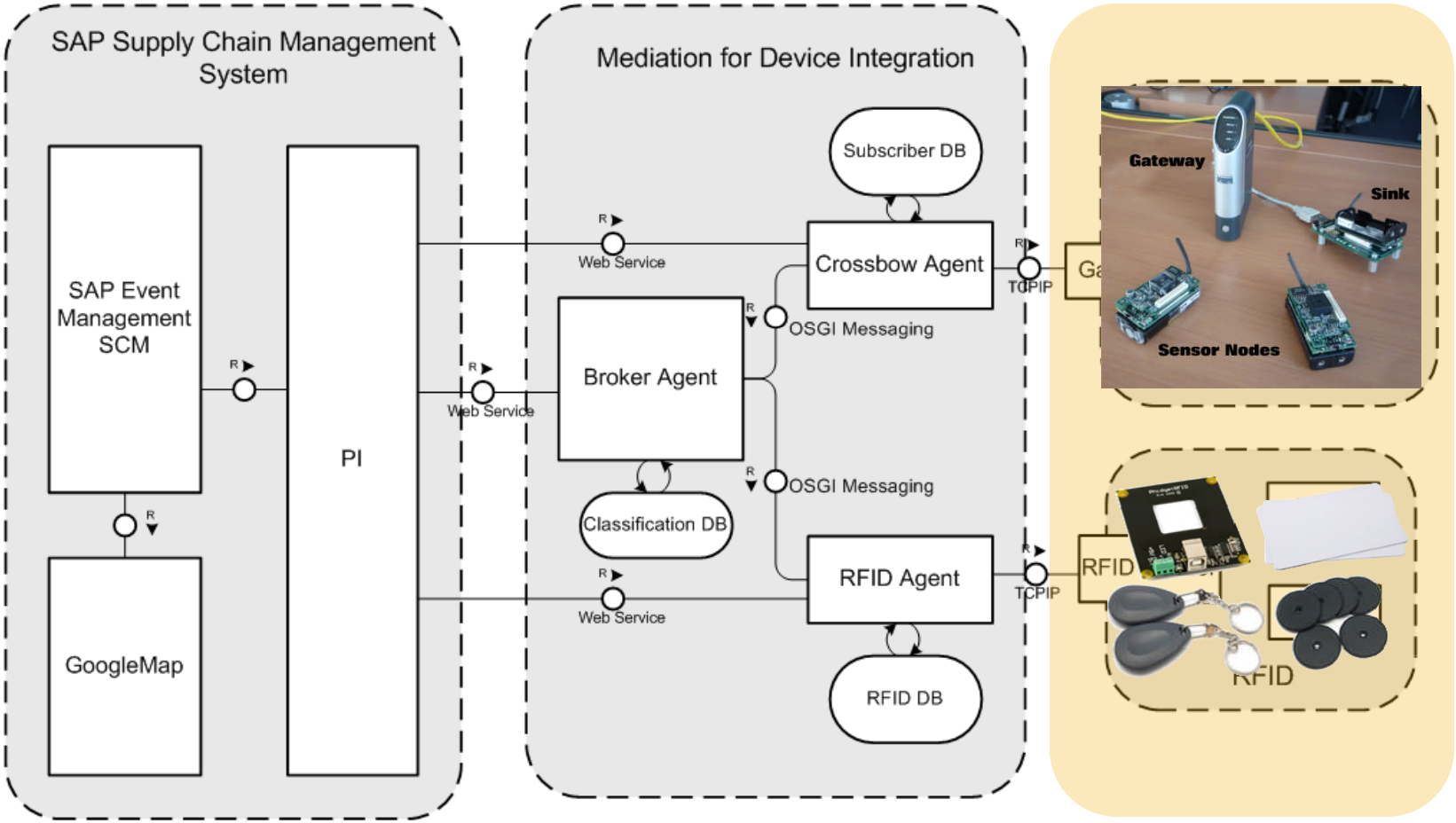
Overall Architecture



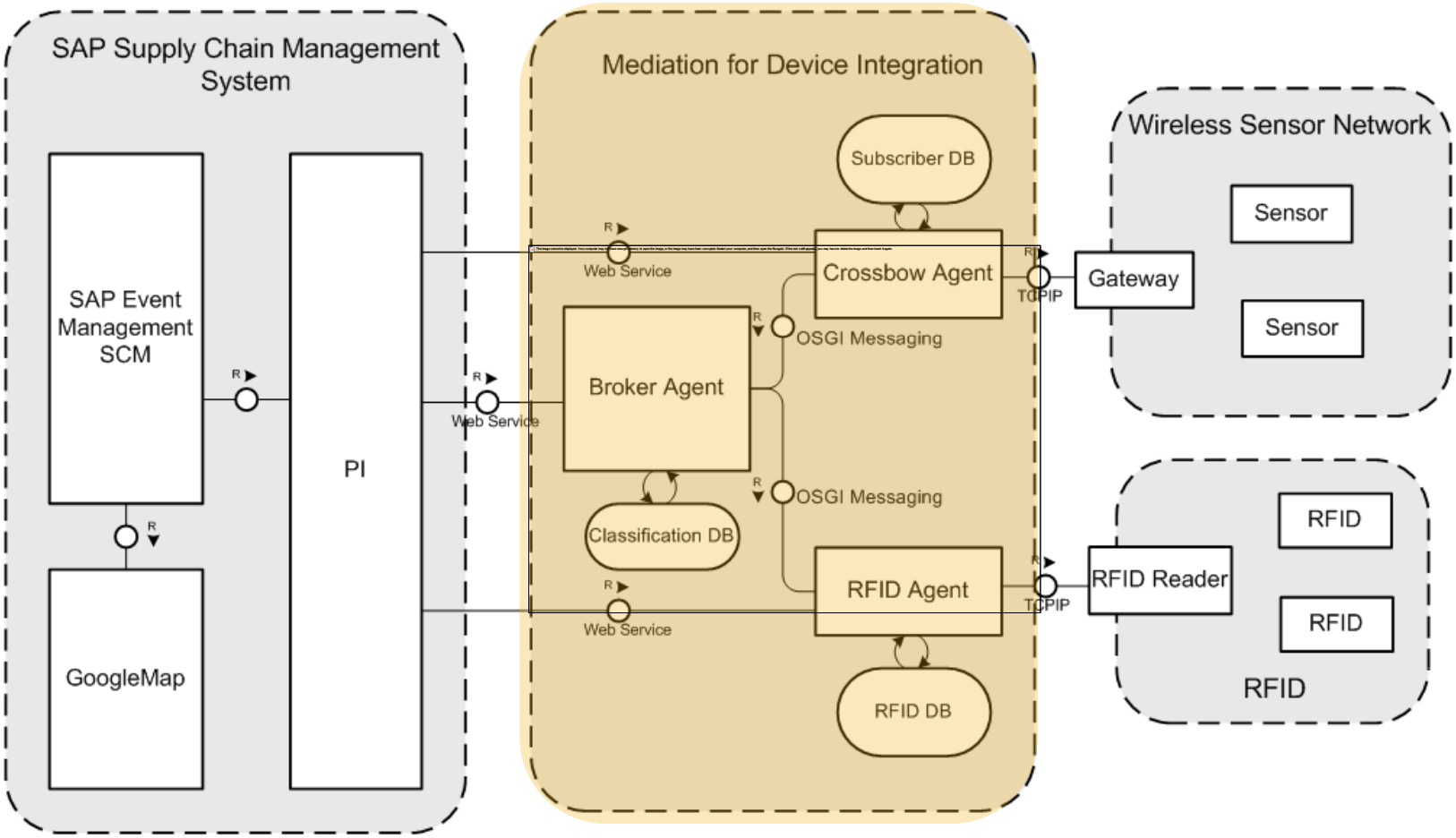
Overall Architecture
SAP Supply Chain Management System



Overall Architecture
Wireless Sensor / RFID



Overall Architecture
Mediation for Device Integration



Middleware for Device Integration

Node resource restriction

CPU, memory, battery

Lack of standardization

Proprietary communication protocol,

Proprietary sensor data format

Information flooding

Lack of security

Unreliability of sensors

Middleware for Device Integration a SAP research Prototype

Need for a mediation layer for a seamless integration

between smart items and supply chain management system

Delegation of information processing

for energy saving

Security mechanisms

MDI in a nutshell

Based on OSGi platform organized around agents

Logical Agent for sensor data processing

Adapter Agent for sensor data acquisition

Each agent exposes a Web Service interface, and enable OSGi communication locally.

Site Manager
the MDI Cockpit

Site manager provides an overall view on available devices.

A device is represented as an Agent.

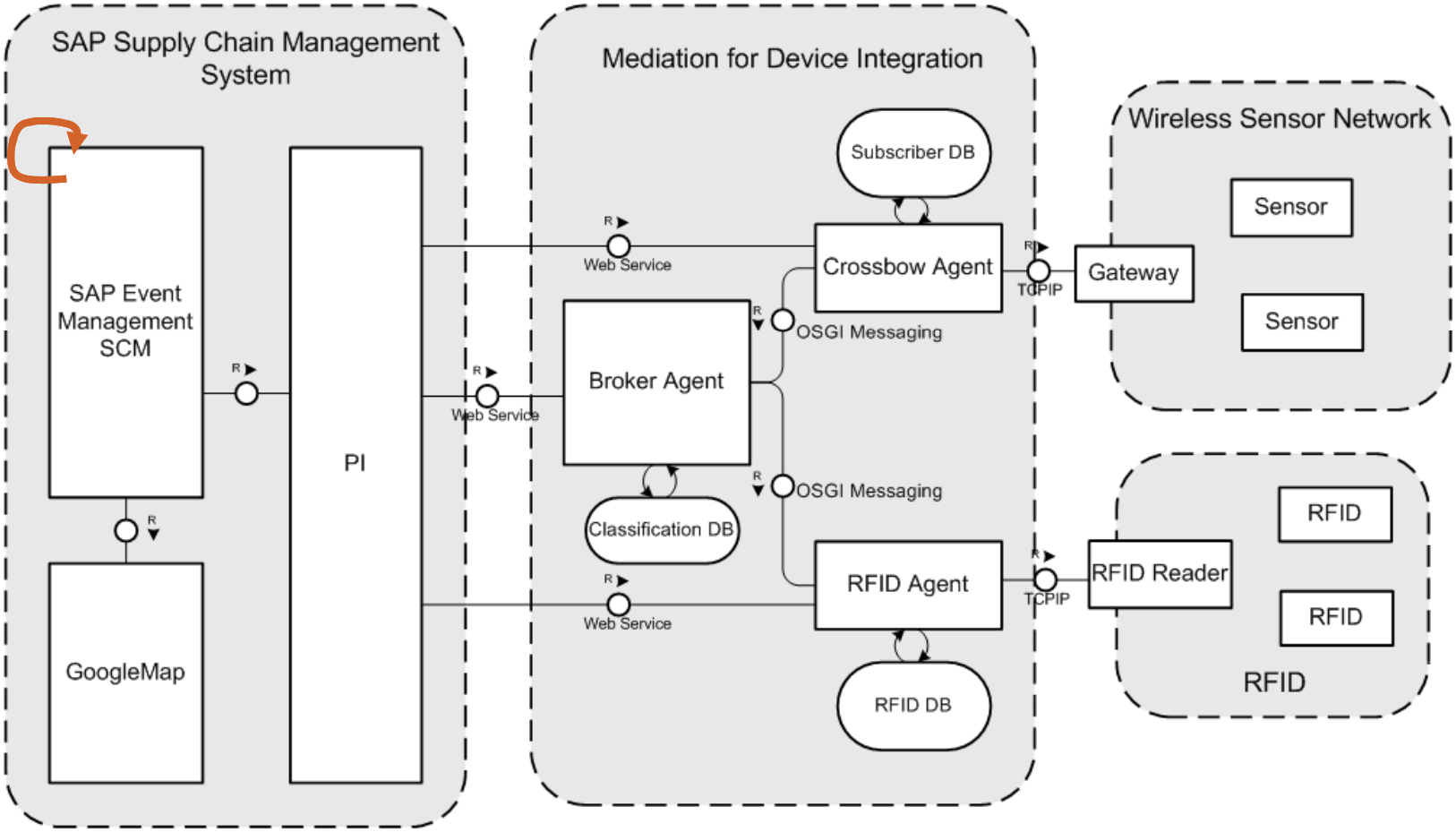
Site Manager is in charge of

Agent Instantiation

Agent Configuration

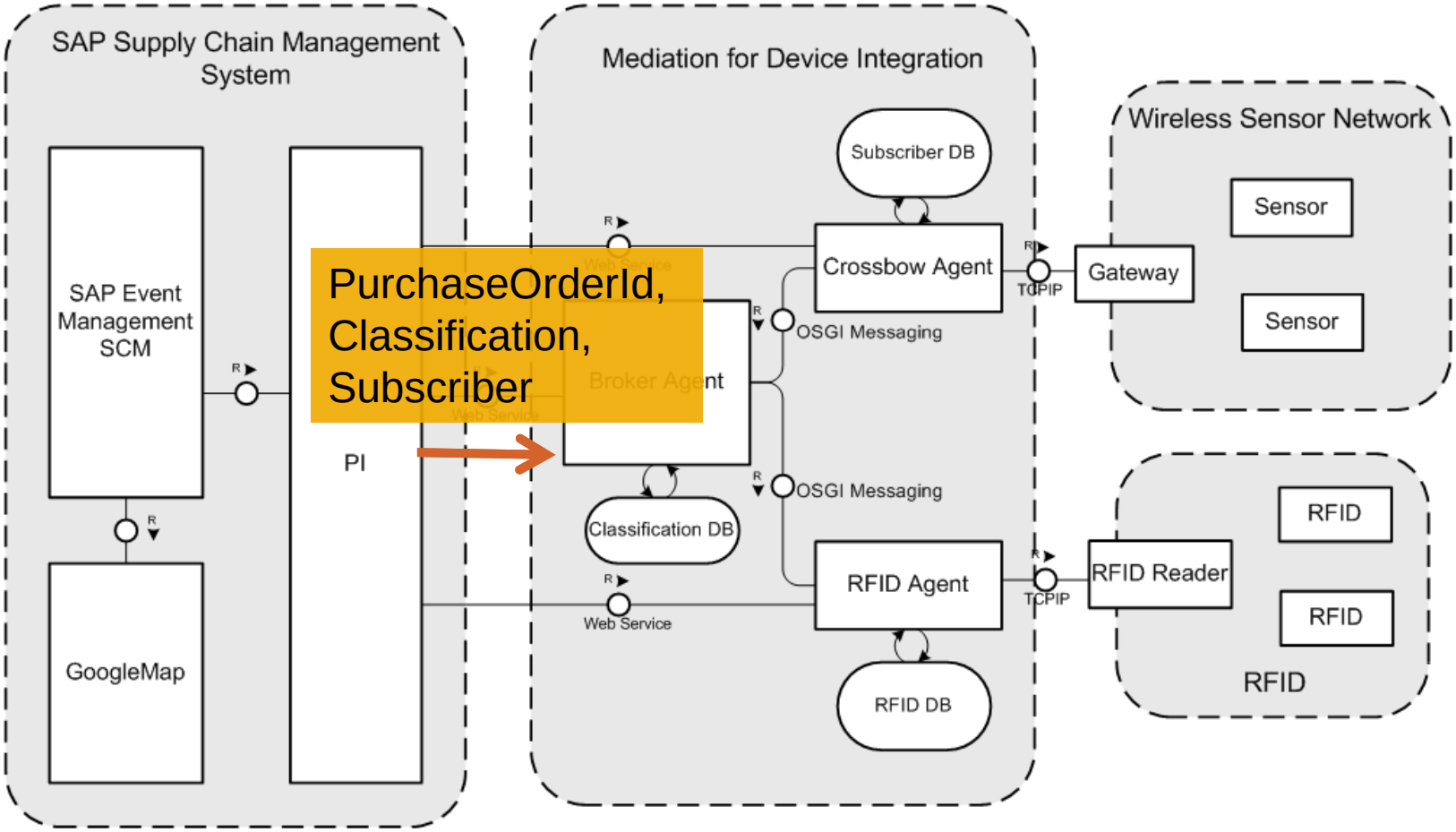
Agent launching

Purchase Order Generation



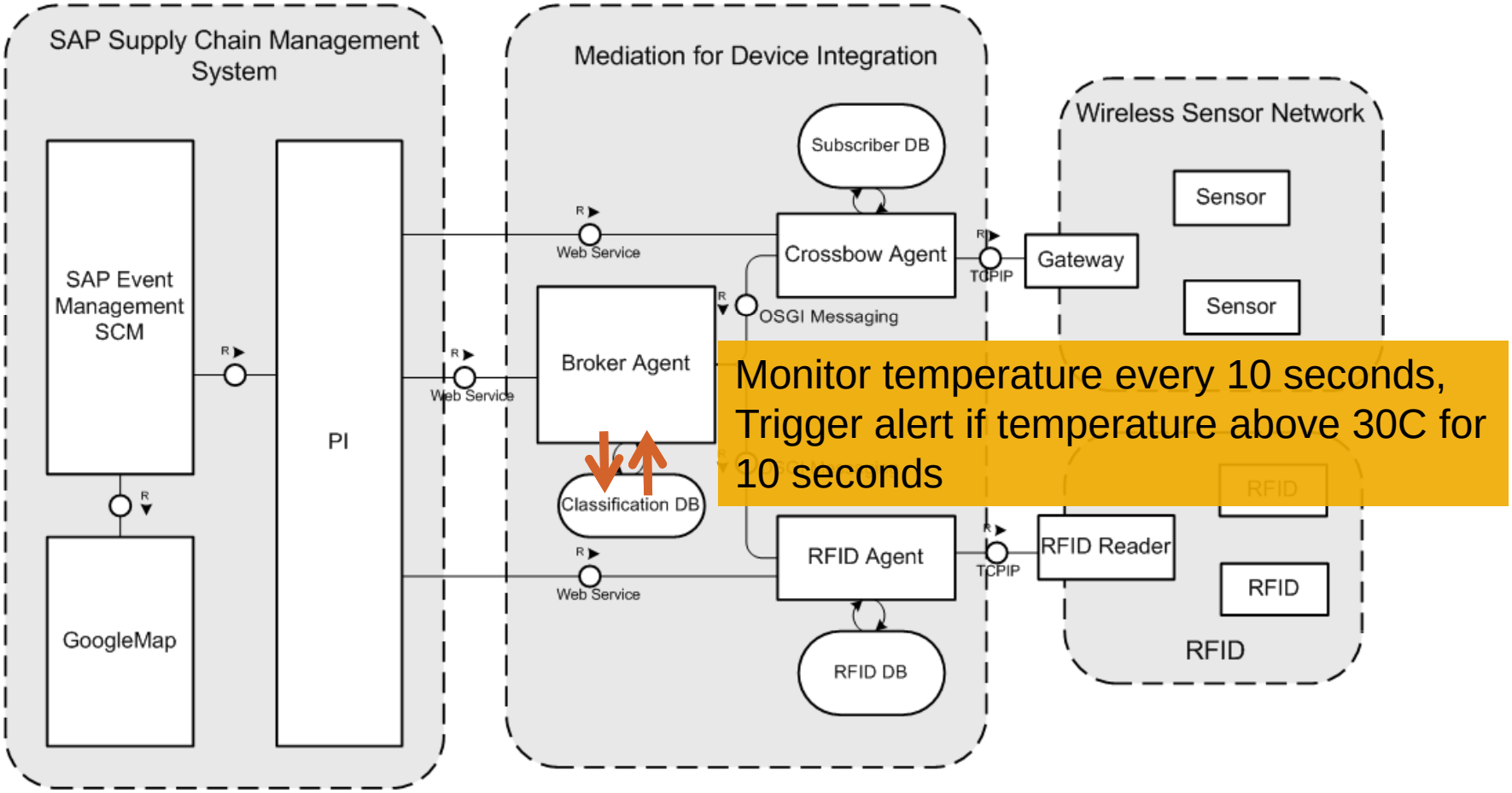
Subscription to good monitoring per classification

PurchaseOrderId, Classification, Subscriber



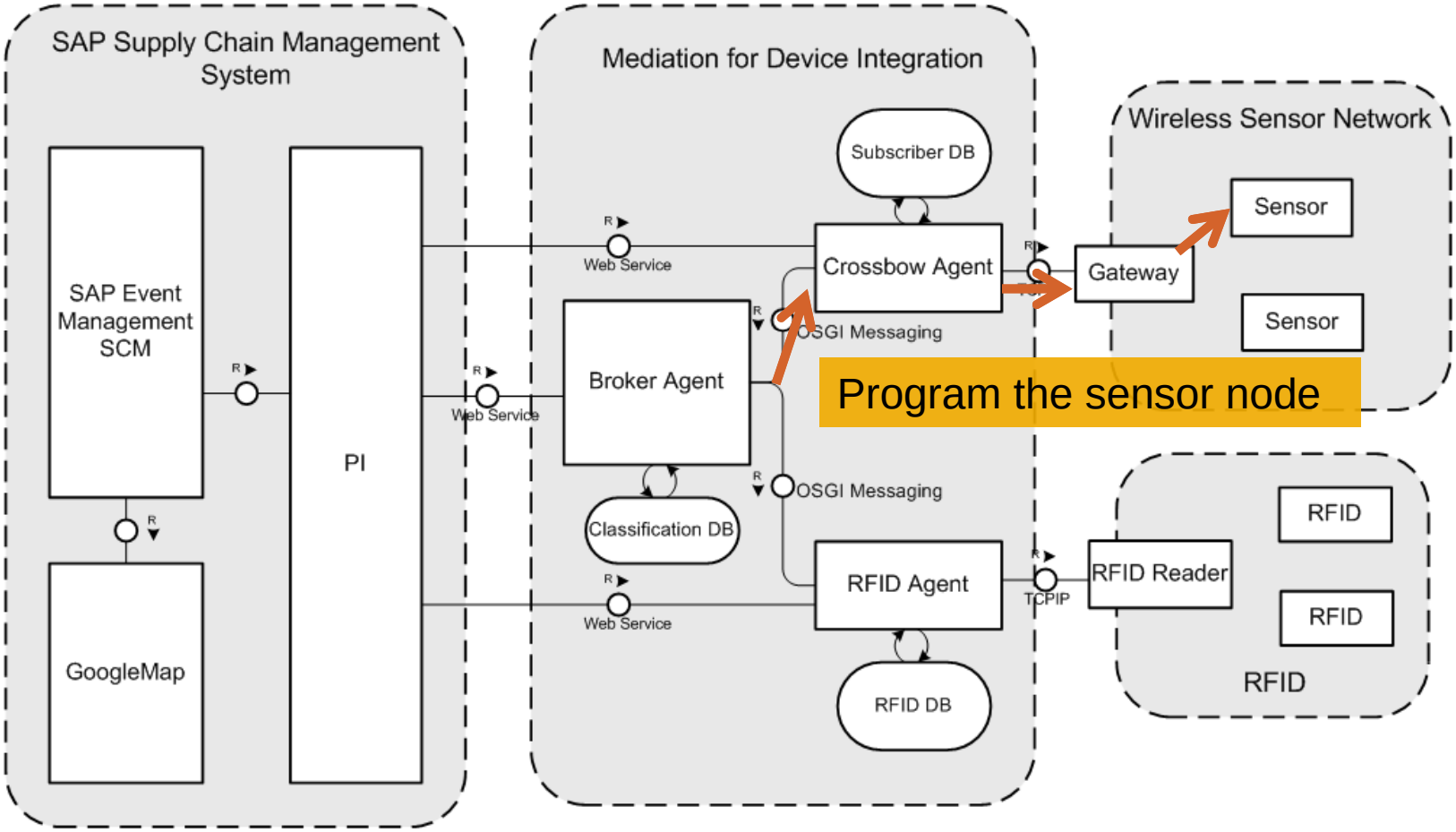
Subscription to good monitoring per classification

Constraint extraction per classification

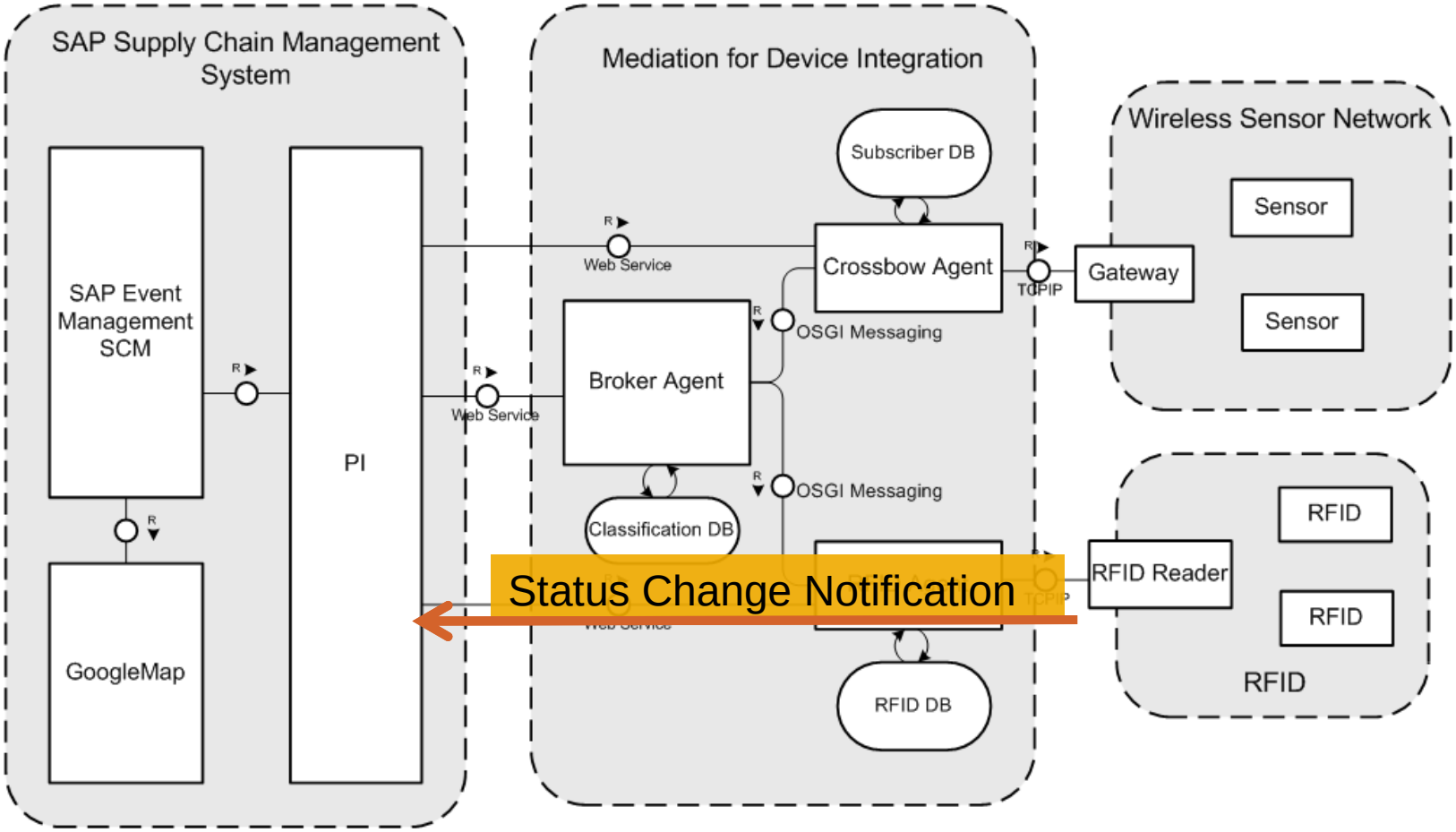


Subscription to good monitoring per classification

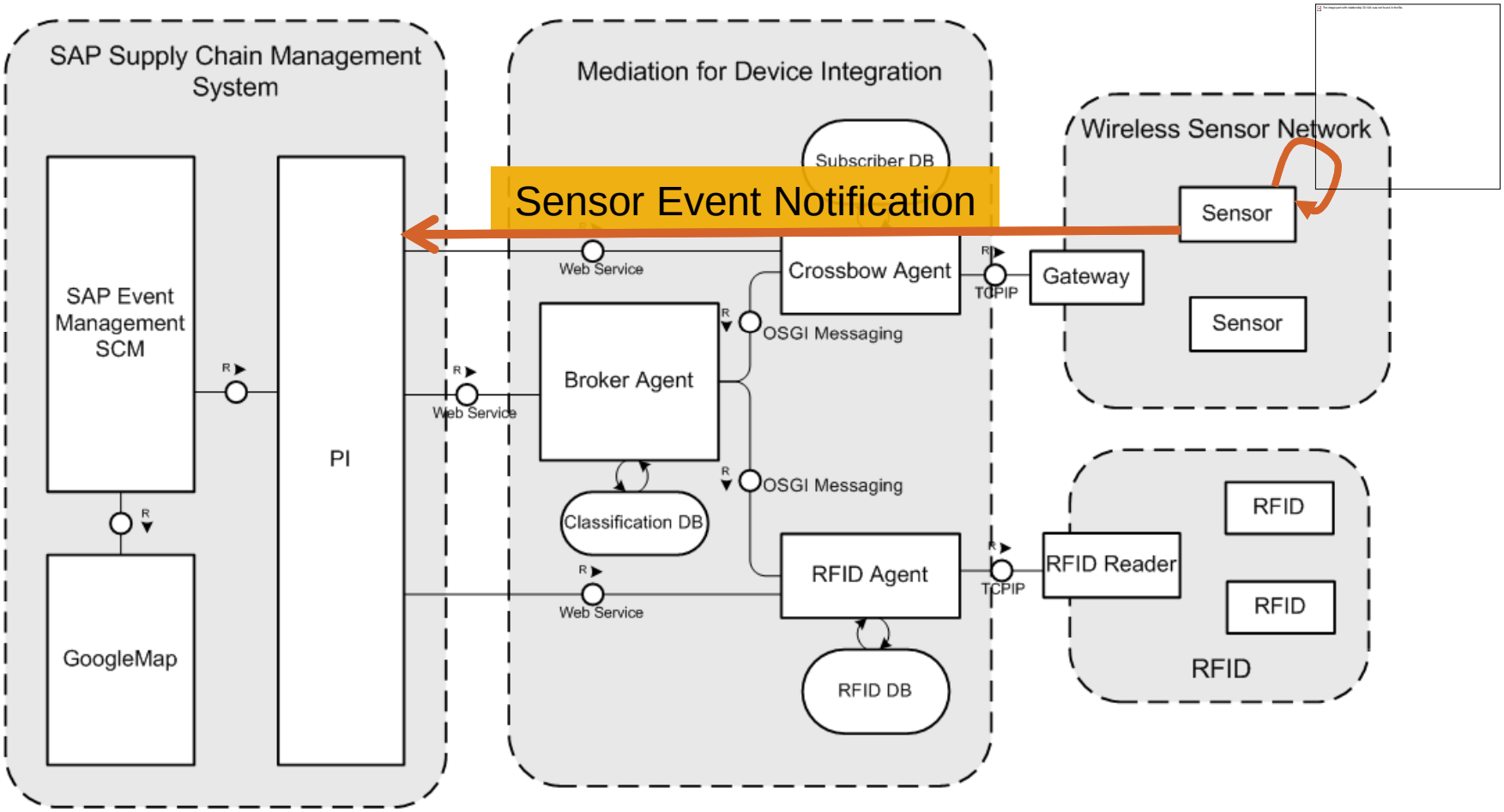
Constraint extraction per classification



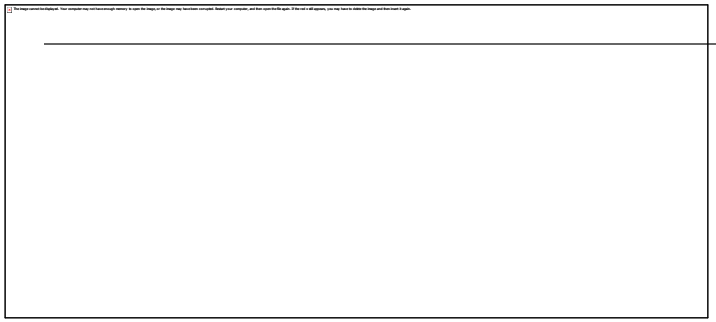
Notification of status change

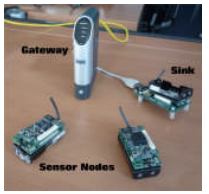


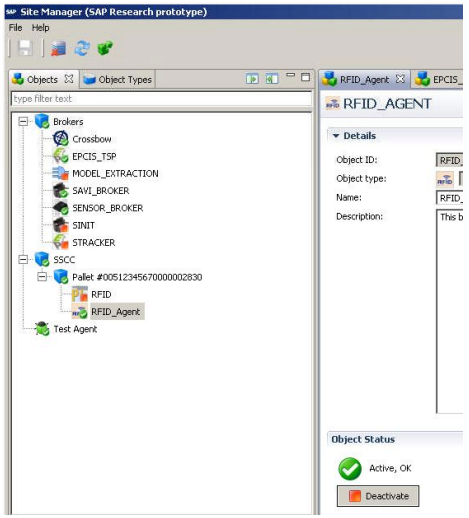
Notification of sensor event

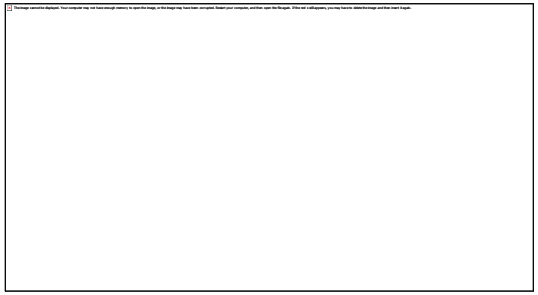


Prototype









Hardware Setup:
CrossBow sensor node

Hardware

MICAz (MPR2400) processing and programmable unit (TinOS, with NesC)

MTS310CA sensor board equipped with acceleration, light and temperature sensors

Energy:

2 1.2V rechargeable battery with a capacity of 2200mA/h

Four evaluation scenarios

Packet sending every 30 seconds

Monitoring and packet sending every 30 seconds

Monitoring, constraint evaluation and packet sending every 30 seconds

Monitoring, constraint evaluation, and alerting.

Battery overhead

Negligible overhead of evaluation of constraint violation.

Following alerting strategies, we observe a gain in energy consumption of almost 60%.

Memory overhead

10% of the loaded code in ROM is dedicated to constraint evaluation

10% of the used RAM is dedicated to constraint evaluation

Bytecode

Set of constraints

Conclusion

Sensor based risk assessment for supply of dangerous products.

Cope with disruption of risk evaluation at the execution of the supply chain.

Prototype developed in the scope of the RESCUEIT project

Future work

Confidentiality of the alerts and monitoring information

Keep a trace of the alerts on the nodes (black box approach)

Thank you!

Contact Information:

Dr. Laurent Gomez
Project Lead RESCUEIT-FR
SAP Research, Sophia Antipolis,
laurent.gomez@sap.com

© 2011 SAP AG. All rights reserved