PROJECT REPORT

National Vaccine Distribution System 'vDistribute'

In partial fulfilment for the course of

APPLICATION ENGINEERING DESIGN

NORTHEASTERN UNIVERSITY

Boston, MA

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1. Problem Statement

Vaccination is the most effective tool to reduce impact of any disease. However, the current vaccination distribution system faces certain issues related to the supply and demand of the vaccines. The way vaccines are stored and distributed are complicated and costly. The supply of vaccines is not always certain. There are cases where there is a shortage of vaccine supply or oversupply of vaccines. This leads to inefficiencies and safety at the provider level. Many times it is observed that the federal system (CDC) is not aware about how vaccines are distributed in the state.

Apart from the supply and demand issue of the vaccines, there exists few more issues.

1) Maintaining the Cold Chain:
Vaccines are highly thermo-sensitive biological substances which have a fixed shelf-life and lose viability over time. Thus maintaining adequate refrigeration needs and proper handling practices should be practiced by all personnel along the supply chain. In the current system, it is seen that many of the vaccines get wasted due to the incompatible storage temperatures.

Also, in the current system the only source of verifiable information on the refrigeration systems and their operating temperature was gathered once a month by a field co-ordinator. Sometimes the changes in the temperature may go unnoticed by the health center staff. The current system lacks continuous monitoring of these refrigeration sites.

2) Incomplete Reports of the Adverse effects of Vaccine:
Currently, the adverse effects of vaccine is handled by The Vaccine Adverse Event Reporting System (VARES). The primary function of VARES is to detect the early warning signals and generate hypotheses about possible new vaccine adverse events or changes in the frequency of the new ones. They maintain the reports of these adverse events. VAERS is a passive surveillance system that relies on physicians and others to voluntarily submit reports of illness after vaccination. However studies show that the information in the VARES report is incomplete.

3) Side Effects of Vaccines
A little is known about the side effects of the vaccines when the vaccines are injected to the patient. The ill-effects of vaccines are only known if the patient reaches the provider for treatment. In other cases the provider or the CDC is unaware of the side or the ill effects of the vaccine.

The current vaccine supply system lacks a homogeneous approach to the issues mentioned above.

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2. The Solution

Information Technology is a powerful tool that could help in alleviating the sufferings. The tool to reduce the issues mentioned is an information system that provides a homogeneous approach to the vaccine distribution system. Using the application engineering technology, efficiency, accountability and safety could be improved whereas public health crises could be reduced.

The application developed in this project 'vDistribute' addresses to all the key issues of the vaccine distribution system. Some of the Key Features are listed below:

Key Features

1) A single homogeneous system for all the vaccine players - Vaccine Manufacturers, Center for Disease control and prevention (CDC), National Distributor, Public health departments at every state, Providers, their associated Satellite Clinics and Patients.

2) Maintaining the supply and demand of vaccines throughout the system:

a) Depending on the demand of the vaccines, CDC ordering vaccines from the Manufacturers and storing the vaccines in the warehouses of National Distributor.
b) Providers creating the orders on contract basis(bi-monthly or monthly) or ad-hoc requests depending on their anticipated demand forecast.
c) Even Satellite clinics associated with the providers can create orders for their activities.
d) Provider orders and satellite clinic orders (after approval of the provider) going through series of approvals from Public Health Department (State Level) and from PHD to CDC (Federal Level).
e) Vaccine orders approved/rejected based on the population of state.
f) Distributor shipping the vaccines to the respective sites based on the vaccines in the inventory.
g) Vaccines being stored in the inventory at the respective sites.

3) Administering vaccines and keeping a track of the records of the vaccines administered to the patients at both provider and at the satellite clinic levels.

4) Providing an overview of the vaccines distributed to a granular level ie. state-wise, city-wise and provider-wise.

5) Maintaining the cold-chain of the vaccines inventoried at Distributor warehouse and at Provider.

6) Complete Financial Model being captured for all the Players
a) Manufactures receiving payments on orders from CDC.
b) Vaccine funding from Federal or State.
c) Distributor receiving payments from CDC, PHD or Provider based on the funding of vaccines.
d) Patient's insurance model is captured and based on the insurance, patient or the insurance company being charged for the vaccine if not funded.
e) Keeping track of the past and the pending payments for all major vaccine players.

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7) Vaccine Adverse Event Reporting System:
a) Providing complete reports to VARES for the failed vaccines state-wise, city-wise, provider-wise and to the minute details such as the side effects reported for the failure by the patient!
b) CDC can send a "Recall" to the manufactures and the Distribution if it thinks that a particular batch of vaccines are failing so that the "failed" vaccine batch is removed from the system and no further orders could be placed on the that particular batch of vaccines.

8) Patients can login and report side effects or ill-effects of vaccines after the vaccine is administered to them.

9) Satellite Clinics can register new patients without the administrator's intervention for their activities.

10) User Profile for all the users in the system could be updated at ease without intervention from administrator.

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3. Scope of the Project

The project has targeted almost all the major players included in the vaccine distribution system however it doesn't cover following points:

a) Actual monitoring of the vaccine transport from manufactures to distributors and from distributors to vaccine sites
b) Complete insurance company profile which includes policies and claims for each patient.
c) Actual monitoring of the warehouses and inventories as the warehouses and inventories are not physically connected to the system.
d) Other departments for CDC, PHD, Providers and Clinics which do not relate to vaccine distribution.

4. Assumptions

The project relies on few assumptions listed below:

1) Every batch produced by the vaccine manufacturer is unique
2) The warehouses and inventories are connected to the system via the telemetry system for monitoring of temperature.
3) There exists mutual understanding between the vaccine players and the payment requests are send after the delivery of the vaccines.
4) Vaccines are considered to be 'fail' if side effects / ill effects are reported by the patient.
5) Once a contract vaccine request is sent to the distributor, the contract remains active in the system.
6) System admin creates only those providers who are registered.
8) Vaccines can be funded either by State or Federal. Once vaccine is federal funded, it cannot be state funded at the same instance.
9) Every time the patient comes for administering vaccine, his/her financial details are taken.

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5. Object Model

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Business Class: A singleton class which manages the whole ecosystem. Consists of a ConfigureSytem class to initialize the business class.

Vaccine Class: A preliminary class which has the global vaccine information such as name and code, disease and VIS date. Aggregate class of VaccineCatalog consists the list of vaccines.

Disease Class: A preliminary class for capturing disease information such as name and code. It has its aggregate class Disease Catalog.

Manufacturer, CDC, Distributor, PublicHealthDepartment, HospitalEnterprise : Enterprises of the system extending the abstract class Enterprise consisting of their Organanizations, UserAccountDirectories, PersonDirectories and Work Queue.

Organization: an abstract Class with classes - CDCOrganization, DistributorOrganization, EnterpriseAdminOrganization, ManufactureOrganaization, PHDImmunizationOrganization, HospitalOrganization, PatientOrganization and SatelliteClinicOrganization extending it.

Person: an abstract class having aggregate class PersonDirectory and classes - CDCEmployee, Distributor,EnterpriseAdmin, ManufacturerAdmin, Provider, PublicHealthDepatmentEmployee, SatelliteClinicProvider and Patient extending it.

UserAccount: A class which stores the login information of the person. It has a an abstract class Roles.

Roles: An abstract class with abstract method to switch panels depending upon the roles - CDCEmployeeRole, DistributorRole, EnterpriseAdminRole, ManufacturerRole, PatientRole, ProviderRole, PublicHealthDepartmentRole, SatelliteClinicProviderRole, SystemAdminRole which are classes extending the role class.

WorkRequest: an abstract class which also has an aggregate class WorkQueue that has the collection of WorkRequest. Basically handles he communication between the different enterprises. It has types: PaymentRequestWorkRequest which handles payments, ProviderVaccineOrderWorkRequest which handles orders and the status from the providers. ShippingOrderWorkRequest which handles the shipped orders from the distributor, VaccineOrderWorkRequest which handles orders from CDC to manufacturers, RecallRequest which handles recalling of the particular batch of vaccines.

VaccineProduct: Once the manufacturer produces vaccine more information of the vaccine vial is captured in this class such as quantity, manufactureDate, expiryDate etc.

AdministeredVaccine: Once the vaccine is administered to the patient, more details are added to the vaccine product such as the patient, date, siteroute etc.

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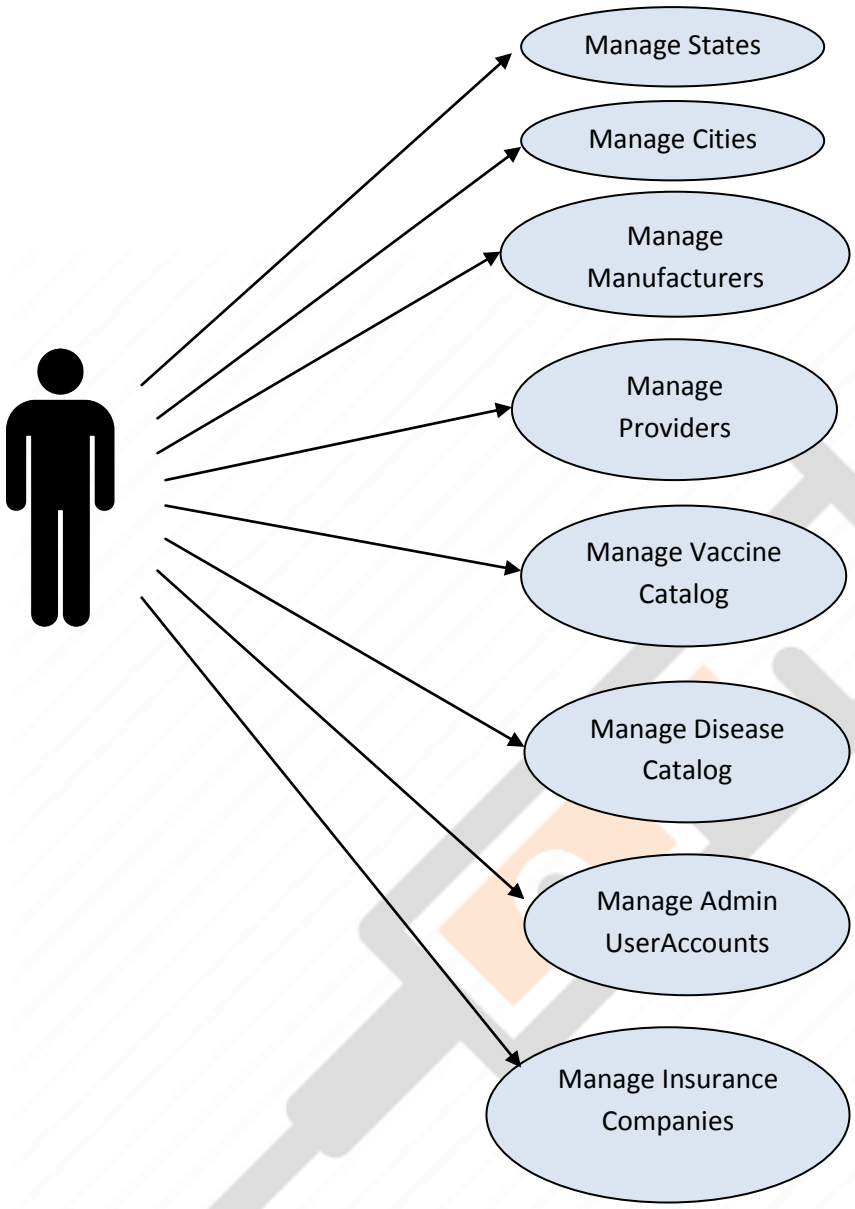
6. Use Cases

1) System Administrator



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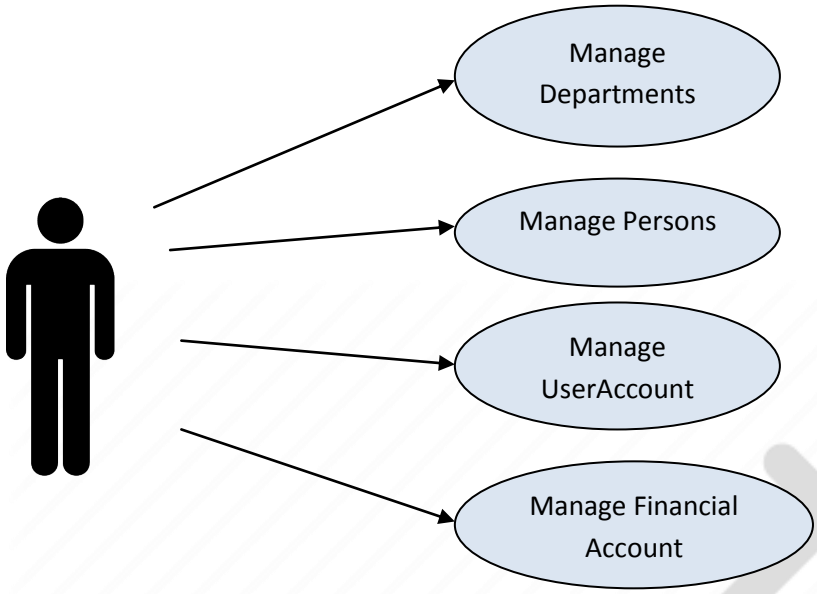
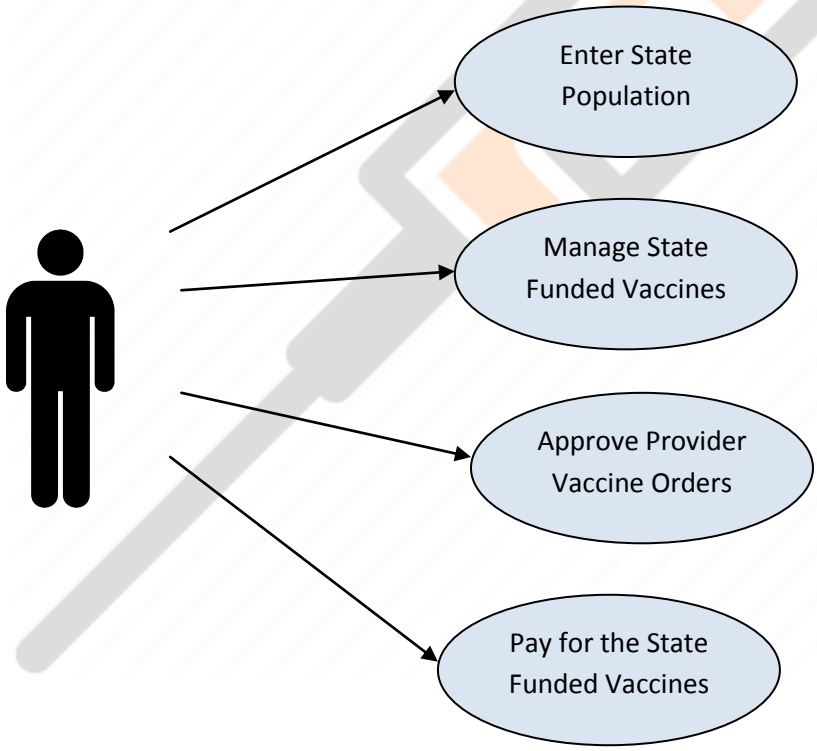
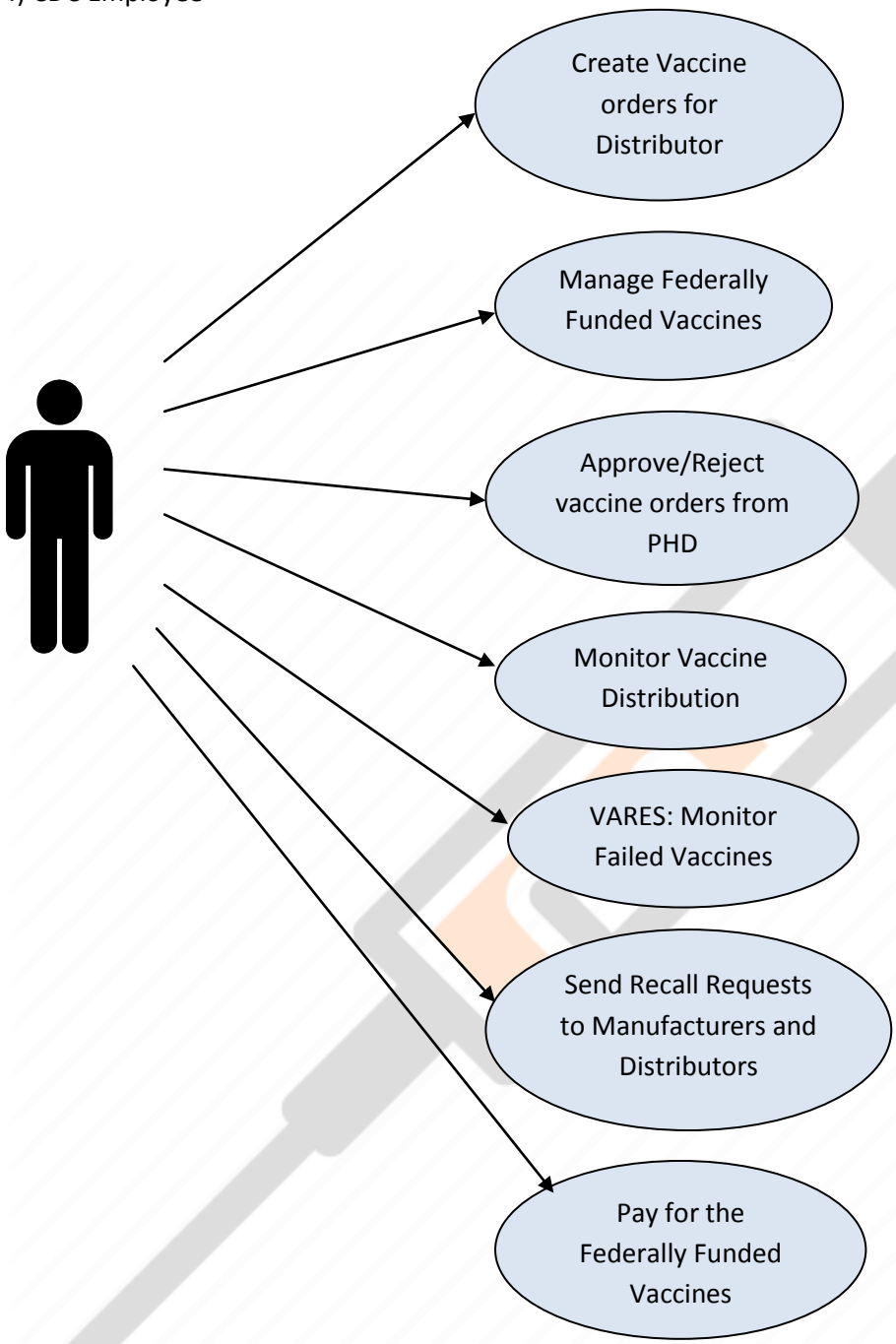
2) Enterprise Administrator



3) Public Health Department Employee



4) CDC Employee



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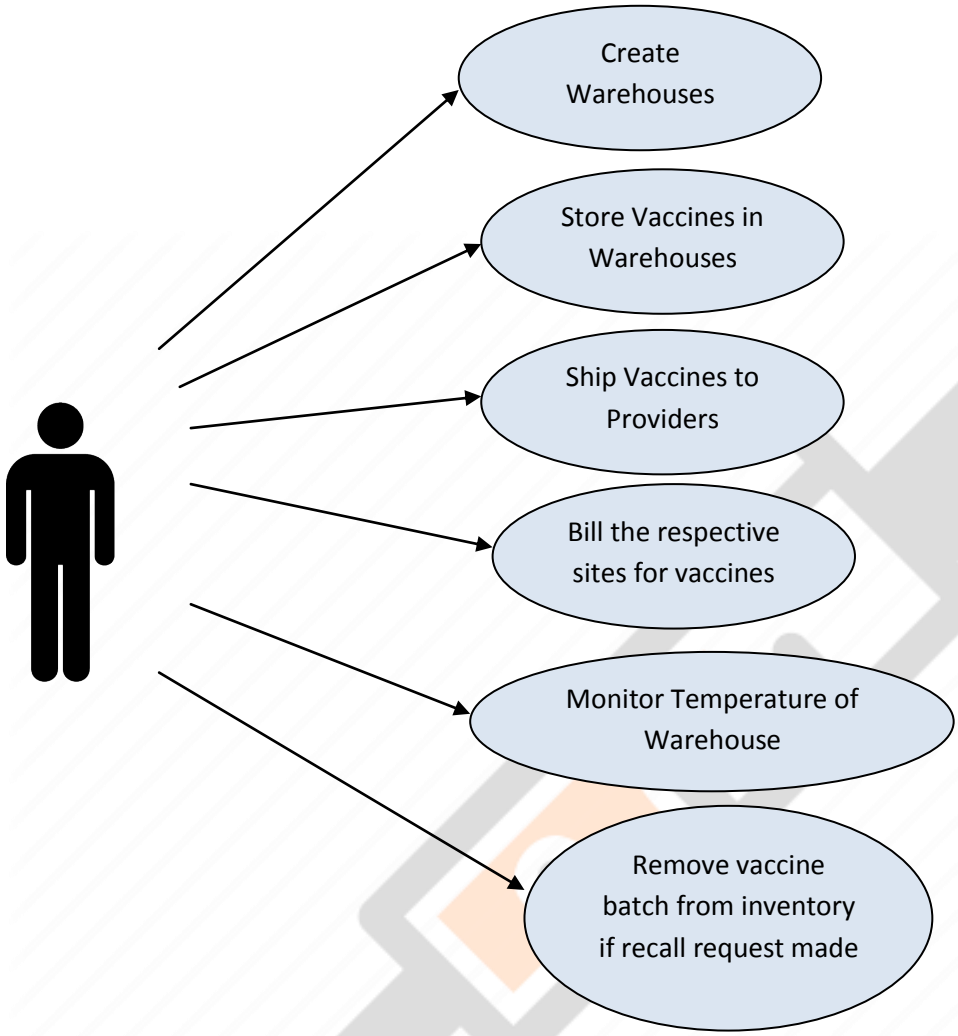
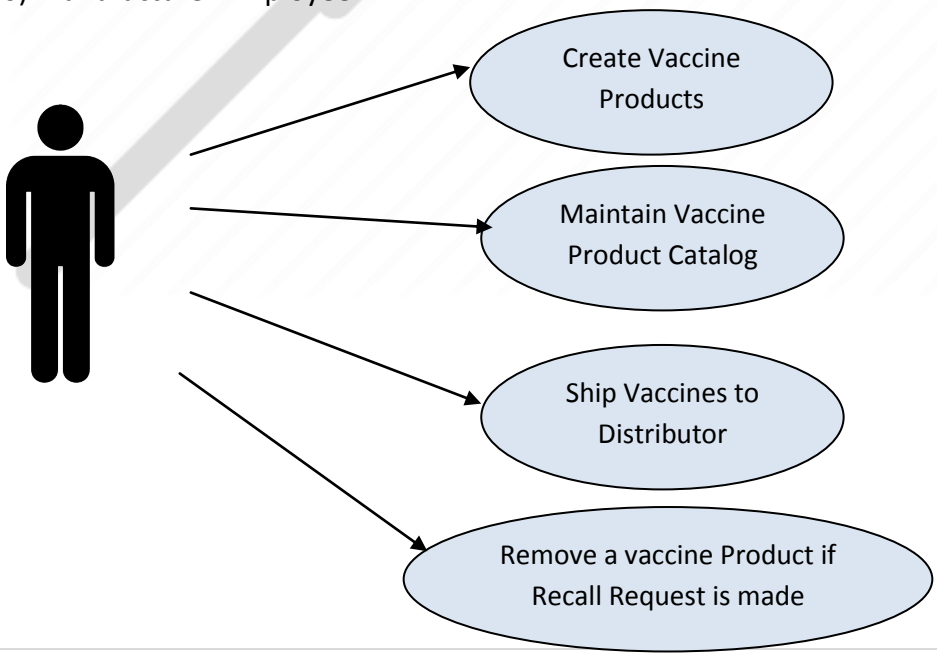
5) Distributor



6) Manufacturer Employee



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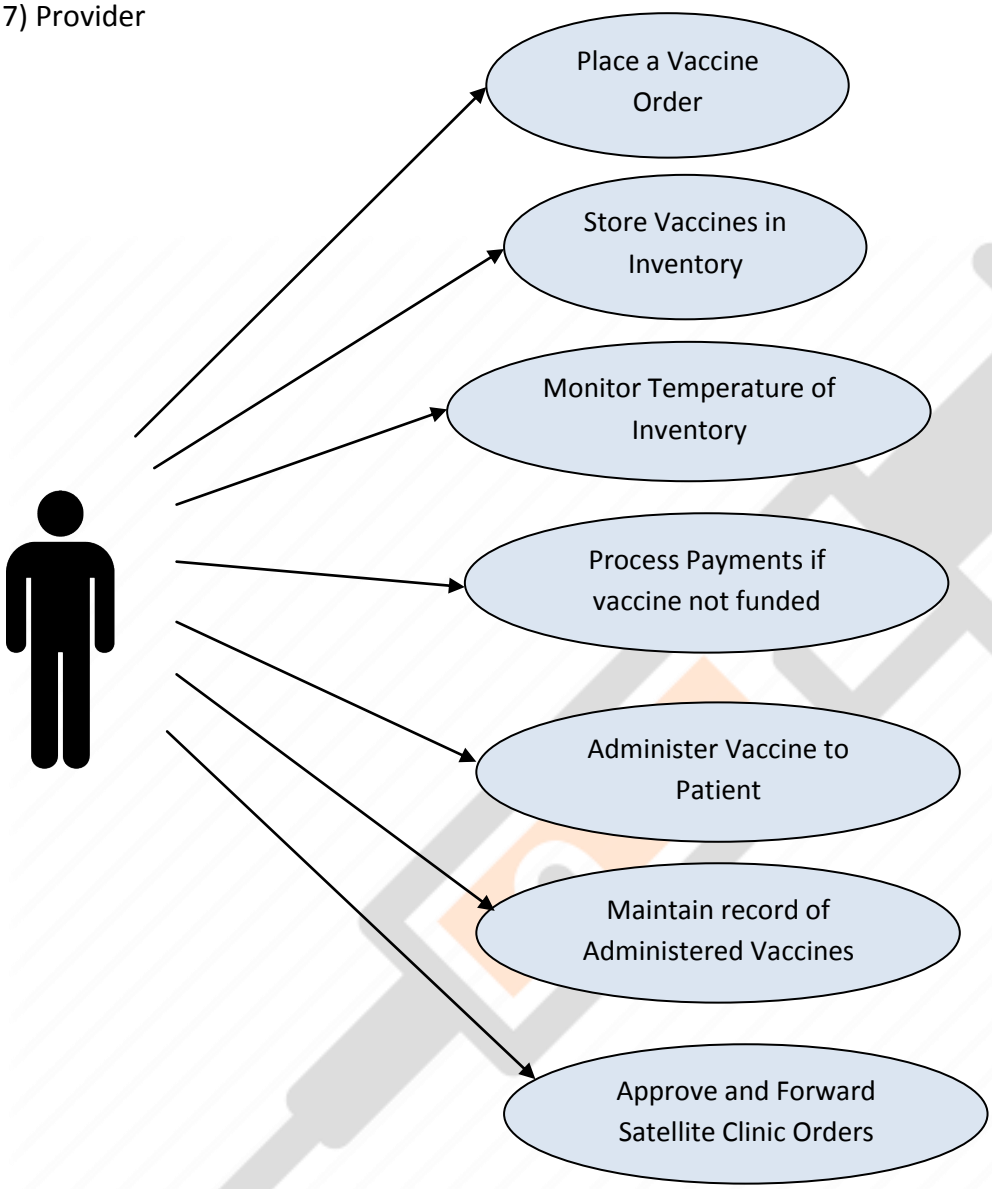
7) Provider



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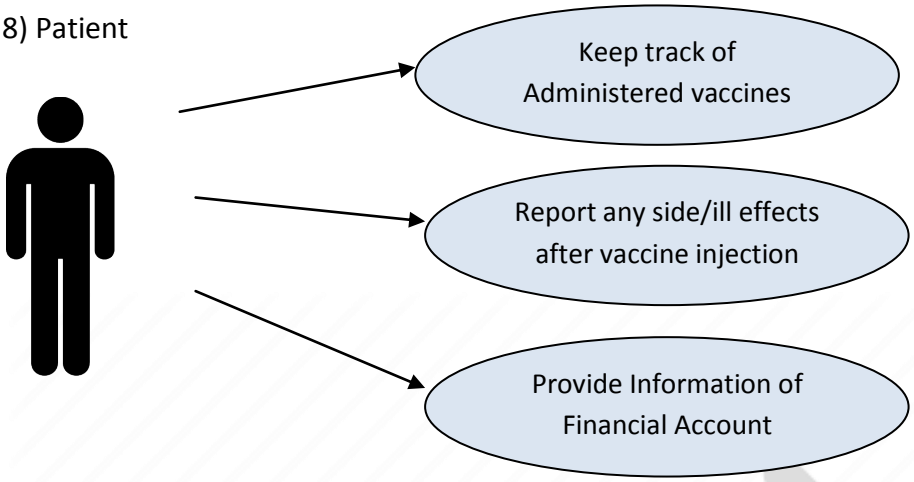
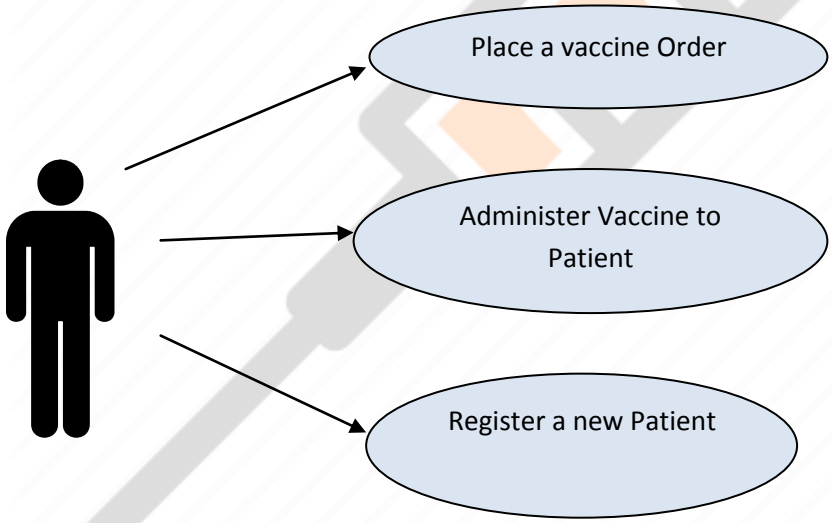
8) Patient



9) Satellite Clinics



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