A Digital Platform for Managing Infectious Disease Risk

A Reference IRM Platform Architecture

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www.nuvalence.com

Sample Foundational Solutions

BlueTrace Protocol

COVID Shield

Google

Proximity Tracing

Important progress has been made by a number of companies in creating much-needed technologies for helping society at large with infection-risk management and response

These technologies provide a number of foundational capabilities. They are not, however, meant for **organization-wide** infection risk management.

What Does Organization-Wide Risk Management Require?

1. **Recognizing and Managing Key Infection-related Nouns:** People, locations such as offices, devices such as building key-card systems, and interactions between these people, places, and things all need to be taken into account when managing organizational infection risk
2. **Use of Decision-influencing Signals:** Proximity tracing, temperature checks, how well an HVAC system is circulating outside air, etc. are all signals that an organization needs to aggregate, compute and compare in order to make infection management related decisions. Many of the foundational capabilities discussed in the previous slide generate these signals
3. **Ability to Assess & React at Scale:** Given the sheer number of entities related to (1) and (2), analysis & workflows are necessary to make informed, organization-wide decisions
4. **Rapid Introduction of Value to Combat Changes in the Disease-context:** New diseases will emerge, and existing diseases will evolve. An organization needs to be able to introduce new value into a defined solution to enable a model that changes as rapidly as the context

Only a **digital platform** can deliver on these four requirements. While point solutions might be able to deliver on some combination of (1), (2) and (3), digital platforms uniquely enable ecosystem-driven decentralized value creation needed to satisfy (4)

Through a digital platform, we can return to work and remain at work, ensuring that the impact on our livelihood is minimized when future events happen

Context for Understanding the Need for Organizational Infection Risk Management

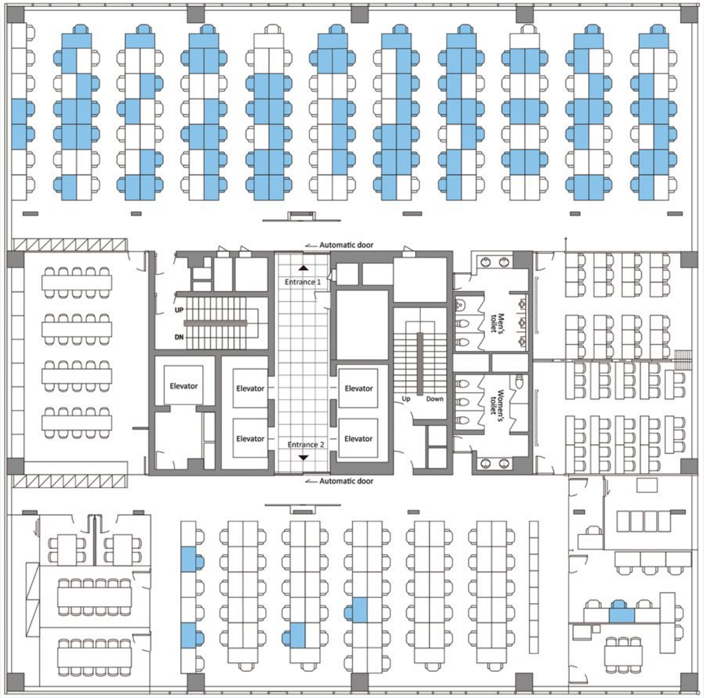
Organizations need to assume that other outbreaks will happen;
Only a “design for failure” mentality will suffice going forward

Core Thesis

Infections do not respect organizational boundaries. A solution is required that equips an organization to **V**erify infection status, **M**anage policy, and organize a **R**esponse (**VMR**) when infection does happen. Solutions need to be aware of the physical structure of an organization and work across people, location & interaction boundaries to deal with infection risk

An example of effective VMR can be seen in a single, canonical case study that defines this problem domain well. The human-driven but not scalable response of an outbreak at a Seoul, South Korea call center

March 8th, 2020 Outbreak in a Call Center in Seoul, South Korea



*Blue color is the seating of an infected person

- **March 9th, 2020:** Joint task force established to investigate and manage the situation. Building is closed. Floor plans and intra-floor traversal are mapped.
- **March 9th-12th, 2020:** Testing of employees
- **March 13th-16th, 2020:** Contact tracing effort sends 16,628 text messages to rapidly communicate and control the situation
- The response protocol was so effective, that the stop of the spread of infection can be visualized in the seat map to the left. **Through a VMR-like approach the infection was contained before it spread to the other half of that floor**

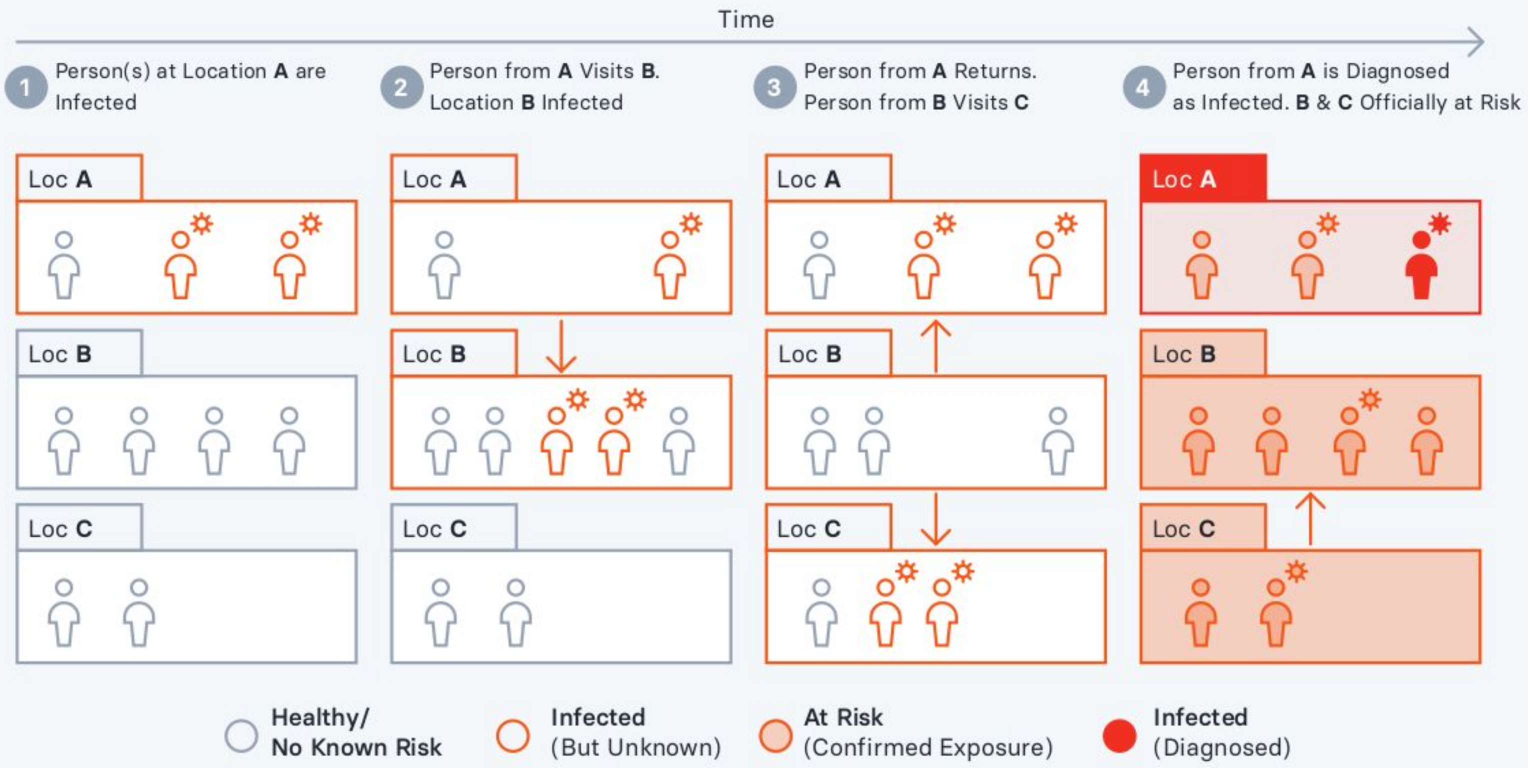
Reference: Park SY, Kim YM, Yi S, Lee S, Na BJ, Kim CB, et al. Coronavirus disease outbreak in call center, South Korea. Emerg Infect Disease. https://doi.org/10.3201/eid2608.201274

But this effort was **(a)** entirely manual **(b)** required a level of effort that is not scalable at most organizations. A digital platform must exist that makes this style response accessible, effective, & efficient

Most organization are even more complex. They have multiple locations, large numbers of employees, vendors, and visitors. They also have a wealth of real-time information that is completely untapped in the context of infection risk management.

To understand the complexity, imagine the following scenario:

Understanding Transmission Across Locations (Left to Right)



How can an organization manage this situation if they don’t have a fundamental understanding of their organizational structure, relationships between people and places, and knowledge of infection-related information? They can’t. A formal structure is required

The Structure of a Solution

An IRM Platform needs to provide a way to conceptualize and model an organization in the context of infection risk management. Infection risk management is a function of people, physical locations (defined at various levels of granularity), systems that generate signals related to infection risk, and policies for managing various scenarios.

Key IRM Definitions

Noun	IRM Platform Definition
Site	A physically bounded area (e.g. an address, building, floor). A Site may contain other Sites in a hierarchical form (Campus->Building->Floor)
Member	A representation of a person. A Member can be assigned to any number of Sites
Signal	A metric related to and/or generated by a Member or Site. Examples include temperature readings for Members, sanitization recency for a site, or proximity hints detected when Members are near each other. A signal is composed of the metric itself and one or more participants (a participant is a Member or Site).
Interaction	A special interpretation of a Signal where the metric indicates a physical encounter between one Member or Site and another Member or Site.
IRM Policy	A set of one or more rules that describe how the solution should react to any change in Members, Sites, Signals or Interactions
Organizational Entity (OE)	A grouping construct that allows for the binding of Sites, Members, and IRM Policy into a common scope. OEs can contain other OEs, allowing for nested inheritance model. OEs can be used to model scopes such as departments, subsidiaries, or “work styles” (e.g. factory work, office work)

All OEs, Members, and Sites are associated with an Infection Status and a 0-100 Risk Score. These two concepts define the current known infection state and the likelihood of becoming infected, based on signals

Infection Status Assigned to Members, Sites and OEs

No Known Infection: No information exists to indicate either infection or exposure to infection.

Exposed to Infection: Information exists that exposure has occurred, via an Interaction, between something with a status of 'No Known Infection' and something with 'Suspected Infection' or 'Confirmed Infection.'

Suspected Infection: Information exists that an infection is likely, but it has not been confirmed by a Member or by a medical professional.

Confirmed Infection: Information exists that an infection exists and is verifiable

Risk Scores are Made of Two Categories Influenced by Signals

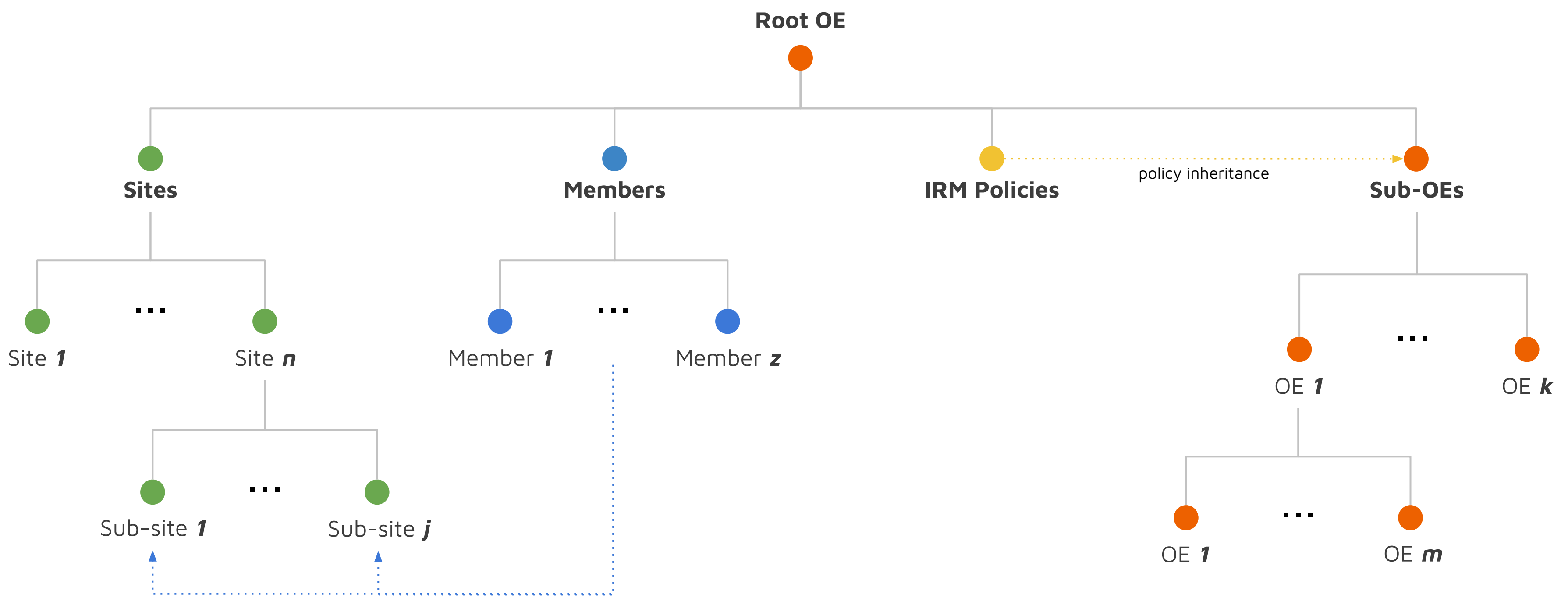
Basis Category Signals + Active Category Signals = Realtime Risk Score

Basis Category: Signals in the Basis Category change infrequently. These signals are related to defined long term policy, location type (office, warehouse, etc.), and other factors such as job type. Basis Category signals define underlying, systematic risk

Active Category: Signals in the Active Category are constantly changing. They include information from employee self-reporting, temperature checks, 3rd party observed illness, building access, etc.

Realtime Risk Score: The higher the Risk Score, the more likely that part of the OE will get infected. Minimizing Risk Score is a key VMR goal

Visualizing the Relationships in an IRM Model



Each Member is assigned to one or more Sites. An example might be a factory floor manager who manages two different floors in different buildings, or someone who has an office in two different buildings

Each OE can have an entire structure composed of Sites, Members, and IRM Policies. IRM Policies are inherited from parent OEs and enforced in all VMR workflows

An organization can use these concepts to model their organization at whatever granularity they desire. This means an organization can start with a practical, coarse granularity at first (e.g. campus level or building level with basic policy), and refine it to be more granular over time. Let’s start with a simple example of an organizational model

Acme, Inc., Headquartered in Charlotte, NC

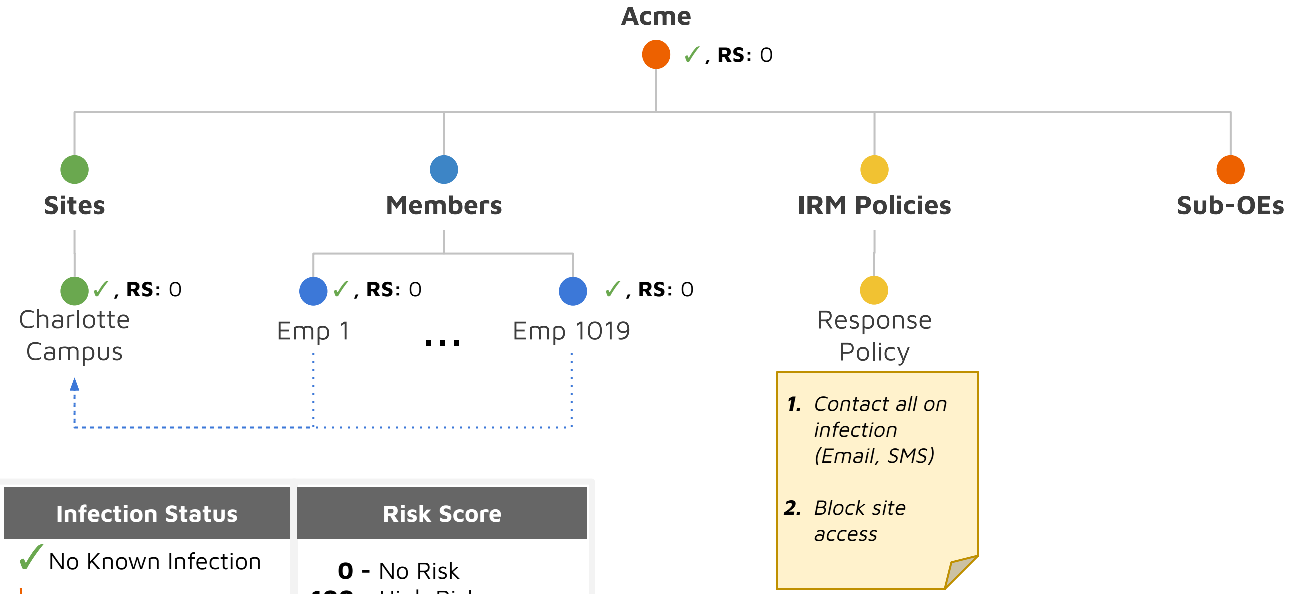
Acme., Inc. has 1,019 employees and one corporate campus in Charlotte, NC. An IRM administrator logs into the IRM Platform administrative portal and:

(1) defines an OE named "Acme"

(2) defines the "Charlotte Campus" Site as the one and only site in the OE

(3) adds all employees from the corporate directory as Members

(4) creates an IRM Policy named "Response Policy" that states that **(a)** all employees will be notified via e-mail and SMS if a single employee reports a 'Confirmed Infection' and **(b)** nearest site access will automatically be suspended for everyone except those assigned to IRM response



Infection Status	Risk Score
✓ No Known Infection	**0 -** No Risk
! Exposed to Infection	**100 -** High Risk
Suspected Infection	*Risk Score is labelled 'RS: '
Confirmed Infection	

Acme’s IRM team decides that they’d like to be more granular in their infection-response management. The “Charlotte Campus” site is actually comprised of 4 buildings. Additionally, 121 of the employees are part of a subsidiary named “Acme Research.” One of the 4 buildings is the Acme Research Building

Acme, Inc. Modifies its OE Model to Allow for Better IRM

An IRM administrator:

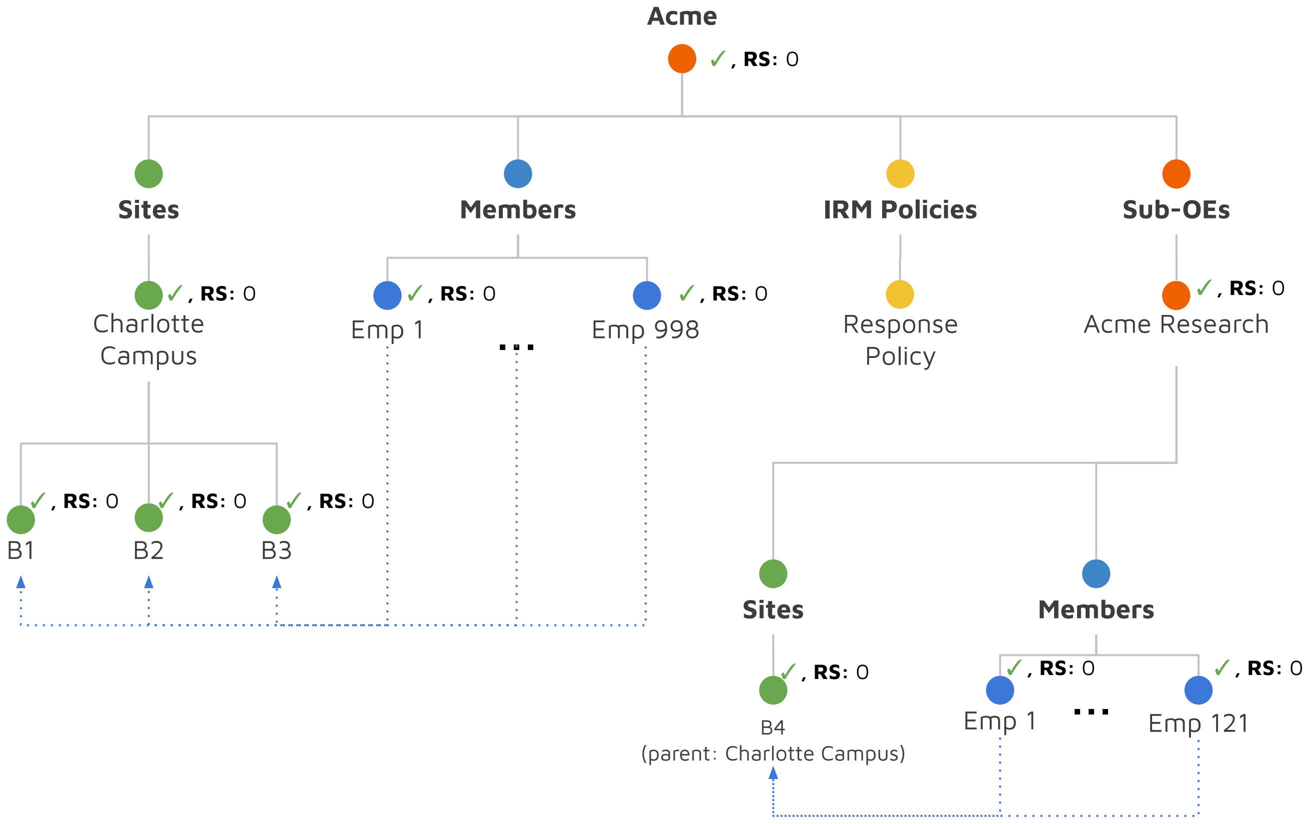
(1) defines Buildings 1-3 as Sub-sites to the "Charlotte Campus"

(2) defines a Sub-OE named "Acme Research"

(3) defines Building 4 under "Acme Research" and sets its parent as "Charlotte Campus"

(4) moves the 121 Acme Research employees from the parent "Acme" OE to the "Acme Research" OE

(5) Assigns all "Acme" Members to their respective buildings and all "Acme Research" Members to Building 4



After adding more granularity to the model, an Acme Research employee reports that they have been diagnosed with an infection.

This signal modifies “Infection Status” and the IRM Platform initiates realtime management workflows. As a result, Risk Scores are modified based on configuration provided by IRM administration to reflect infection and exposure to infection, assigning an RS value of 100 and an RS value of 50, respectively

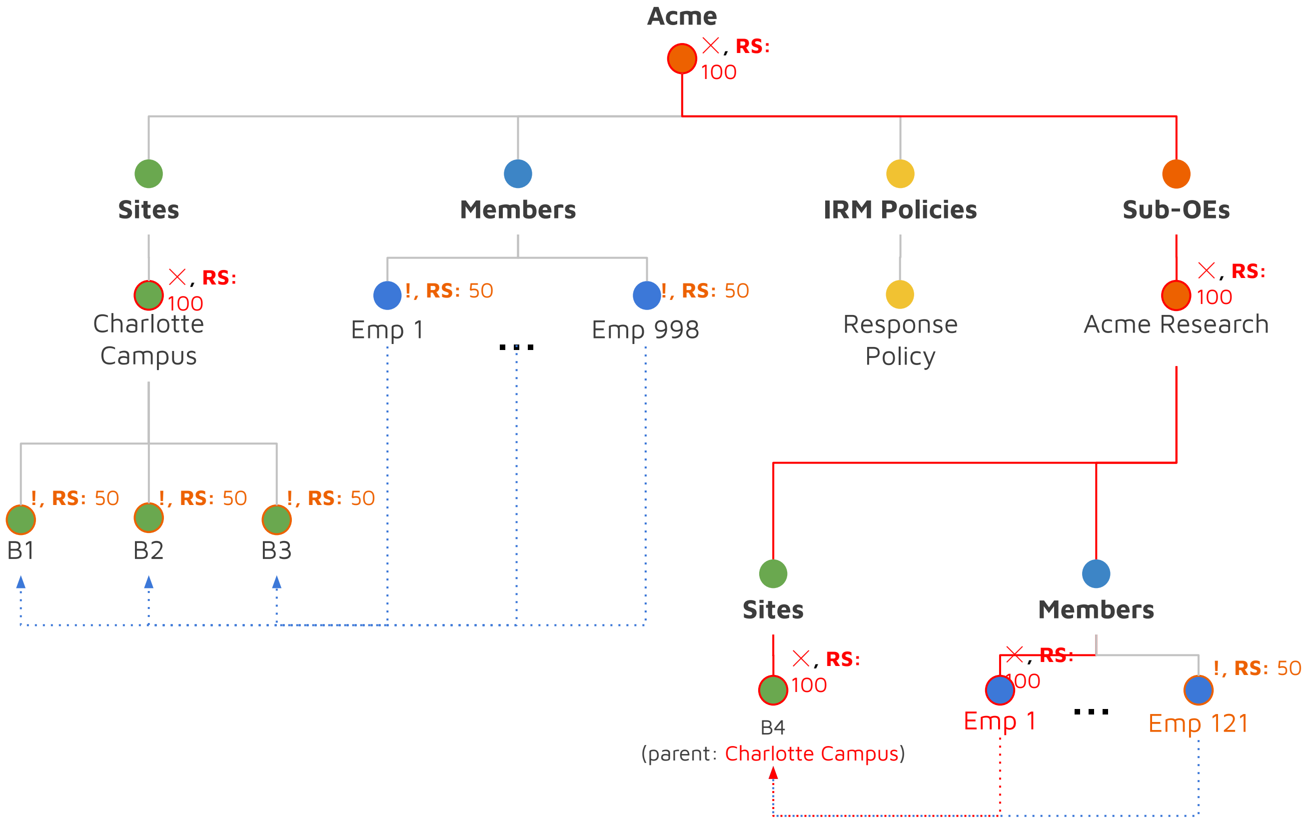
An Infection is Reported by an Acme Research Employee

The IRM Platform initiates core workflows where:

(1) Risk Score is modified, as is Infection Status, for all components of the OE structure that are relevant

(2) policy is triggered. Given that the Response Policy is tied to nearest Site scope, only the 121 Acme Research employees are notified, and access to Building 4 is suspended

NOTE: **Red lines** show algorithmic assignment of a 100 Risk Score. IRM platforms track parent/child infection status relationships. In this case, exposed peers are colored **orange**.



While the IRM Platform initiated a successful response to known infection, the IRM administrator can continue to refine policy and OE structure to allow for an even more precise response, increasing both safety and productivity for future events

An IRM Platform Reference Architecture

In order for an organization to be able to successfully manage future Infection Risk, they need to rely on technology

Nuvalence will create and open-source components of a digital platform architecture that organizations can use as a foundation for their Infection Risk Management efforts

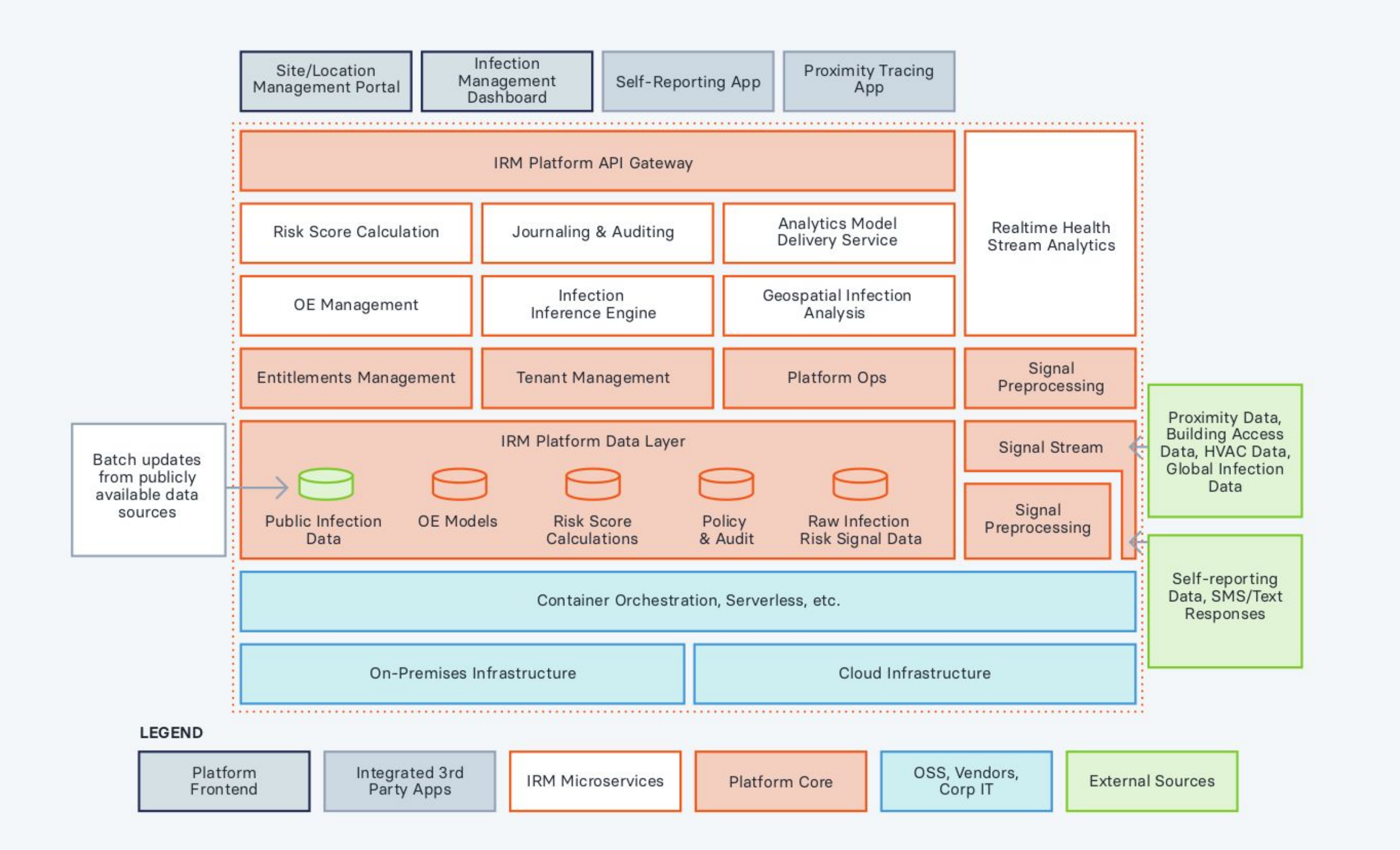
Guiding Principles for an IRM Platform

1. At its core, it should leverage the OE, Infection Status, and Risk Score model defined in these slides

2. It should provide workflows accessible to key VMR personas such as individuals, site managers, and executives

3. It should act as the point of integration and aggregation for numerous 3rd party solutions whose data contribute to VMR-based management. Examples include proximity tracing software, temperature check systems, building access systems, and HVAC data, just to name a few

IRM Platform Reference Architecture



Why is a Digital Platform Required?

1. **Adaptable:** Infection Risk will change over time. New diseases will emerge, as will new approaches. A digital platform provides a technology foundation that is extensible to meet this constant change head-on

2. **Customizable:** Allowing for a fine-tuned outcome specific to each org

3. **Extensible via an Ecosystem:** Many vendors and other 3rd parties are creating critical point solutions. These point solutions need to be stitched together to provide a comprehensive outcome. A digital platform can act as the "connective tissue" in this sort of ecosystem

We look forward to working with you on your Infection Risk Management Platform. Even if you don't work with Nuvalence, we hope some of the thinking in these slides and whitepaper will prove useful

Contact us at new-normal@nuvalence.io

Thank you!

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