



# Singapore Healthcare Management 2024

## Automated infectious disease surveillance system for improved healthcare safety - 4D-DOSS

Shalvi Arora<sup>1</sup>, Jean Xiang Ying Sim<sup>1,2</sup>, Edwin Philip Conceicao<sup>3</sup>, Aung Myat Oo<sup>1</sup>, Siew Kiang Lim<sup>1</sup>, Daniel Tiang Chuanwen<sup>4</sup>, Joseph Kin Meng Cheong<sup>5</sup>, Cai Yiyi<sup>6</sup>, Nicholas Graves<sup>6</sup>, Siow Leng Neo<sup>7</sup>, Shawn See Wee Jin<sup>1</sup>, Sean Douglas Whiteley<sup>8</sup>, Maybelle Auw<sup>8</sup>, Cawin Chan<sup>8</sup>, Weien Chow<sup>9</sup>, Indumathi Venkatachalam<sup>1,2</sup>

<sup>1</sup>Department of Infection Prevention & Epidemiology, Singapore General Hospital  
<sup>2</sup>Department of Infectious Diseases, Singapore General Hospital  
<sup>3</sup>Department of Infection Control, Changi General Hospital  
<sup>4</sup>Office of Service Transformation, SingHealth  
<sup>5</sup>Bed Management Unit, Singapore General Hospital  
<sup>6</sup>Programme in Health Services and Systems Research, Duke-NUS Medical School  
<sup>7</sup>Office of Digital Empowerment, SingHealth  
<sup>8</sup>AxoMem, Singapore  
<sup>9</sup>Department of Cardiology, Changi General Hospital

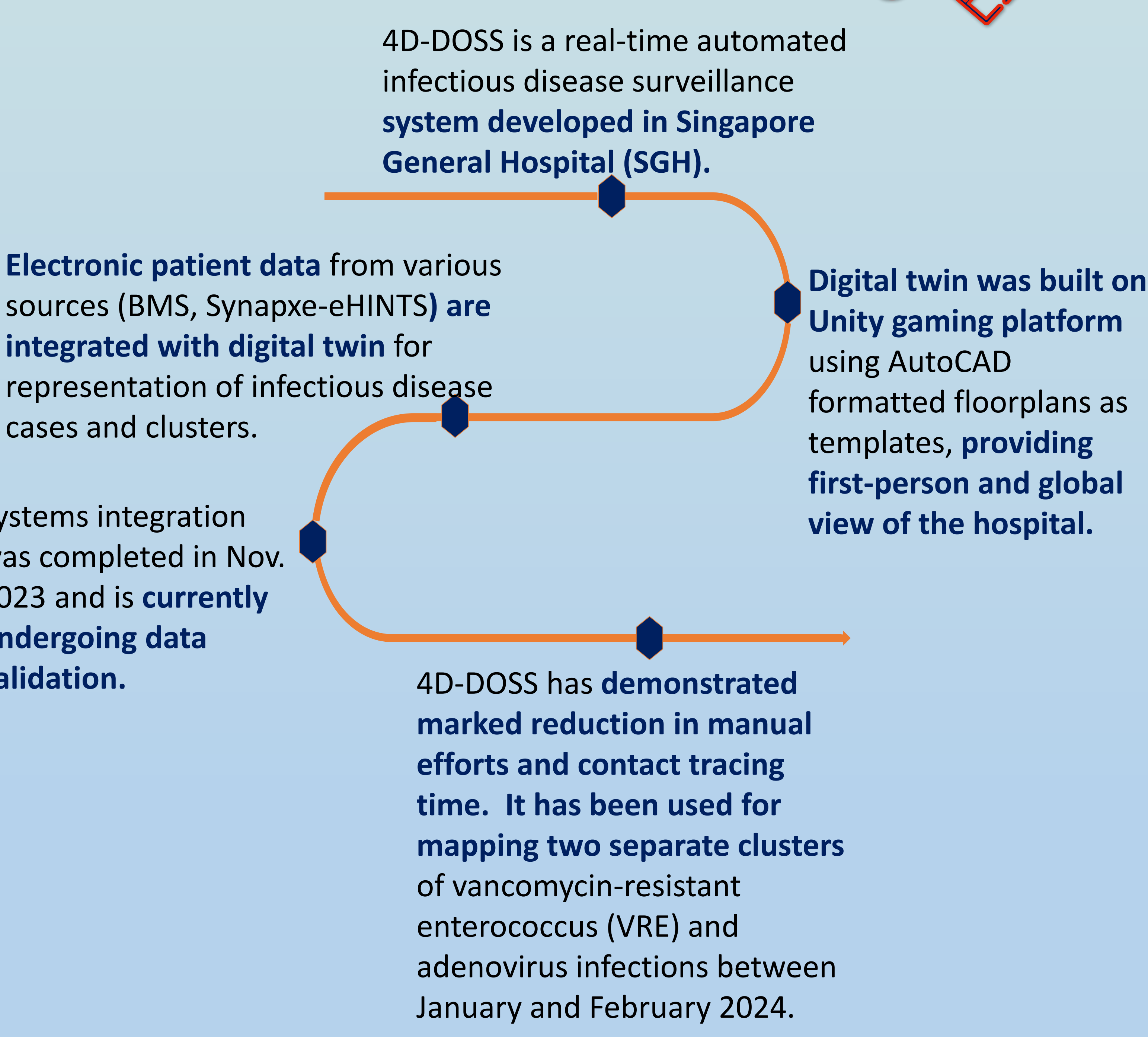
### 1. INTRODUCTION

- Current hospital-based surveillance systems **lack capacity** to capture granular data on dynamic interaction between patients, staff and their environments, thereby limiting their utility for infectious disease surveillance, detection, contact tracing and outbreak response.
- 4-dimensional disease outbreak surveillance system (4D-DOSS) is an automated **all-in-one** surveillance system built on the experience from two-dimensional map-based COVID-19 surveillance.
- It has **capability for integrating healthcare data** from various sources to **spatially represent infectious disease** patients, enhancing cluster detection and generate alerts for early response.

### 2. AIM

1. **Develop digital-twin based real-time automated infectious disease surveillance system** for in-depth situational analysis and spatiotemporal visualization of infectious diseases clusters for enhanced contact tracing and informing infection prevention practices.
2. **Demonstrate utility of 4D-DOSS** for contact tracing and cluster detection.

### 3. METHODS



### 4. RESULTS

- Contact tracing efficiency**
- 4D-DOSS reduces routine contact tracing process from a 7-step manual process (requiring 2hrs/index patient) to a 3-step process also allowing for simultaneous contact tracing for multiple patients within 5mins.

### 4. RESULTS

#### Demonstration of infectious disease clusters

##### VRE cluster

- Occurred in a general ward from 5<sup>th</sup> to 26<sup>th</sup> Feb 2024.
- Involved 16 patients of whom 14 were healthcare associated (positive ≥2-days post-hospitalization).
- 4D-DOSS **demonstrated that there was no spatial overlap** between the patients, **indicating minimal risk of patient-to-patient transmission.**

##### Adenovirus cluster

- Occurred in a general ward from 4<sup>th</sup> Jan to 27<sup>th</sup> Feb 2024, involving 5 patients.
- Initial 4 patients were positive in a hematology ward.
- Spatiotemporal mapping on 4D-DOSS **demonstrated two instances of overlap indicating probable person-to-person transmission:**
  1. 15-days temporal overlap between two of the initial 4 patients in a haematology ward;
  2. 4-days spatiotemporal overlap in intermediate-care-area from 31<sup>st</sup> Jan-3<sup>rd</sup> to Feb 2024 between the fifth case, (positive on 27<sup>th</sup> Feb 2024), and a patient from initial haematology ward cluster (positive on 2<sup>nd</sup> Feb 2024), indicating possible person-to-person transmission.

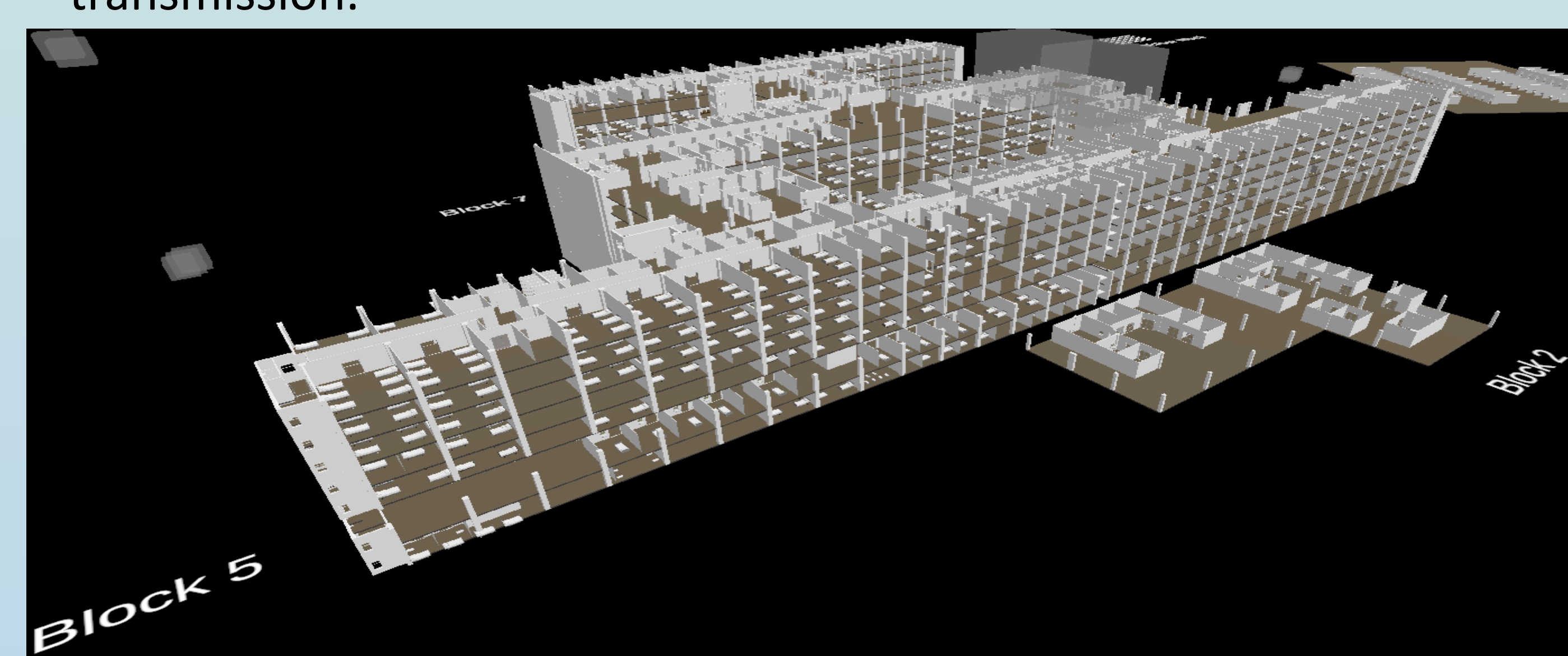


Figure 1: A global view of the hospital blocks

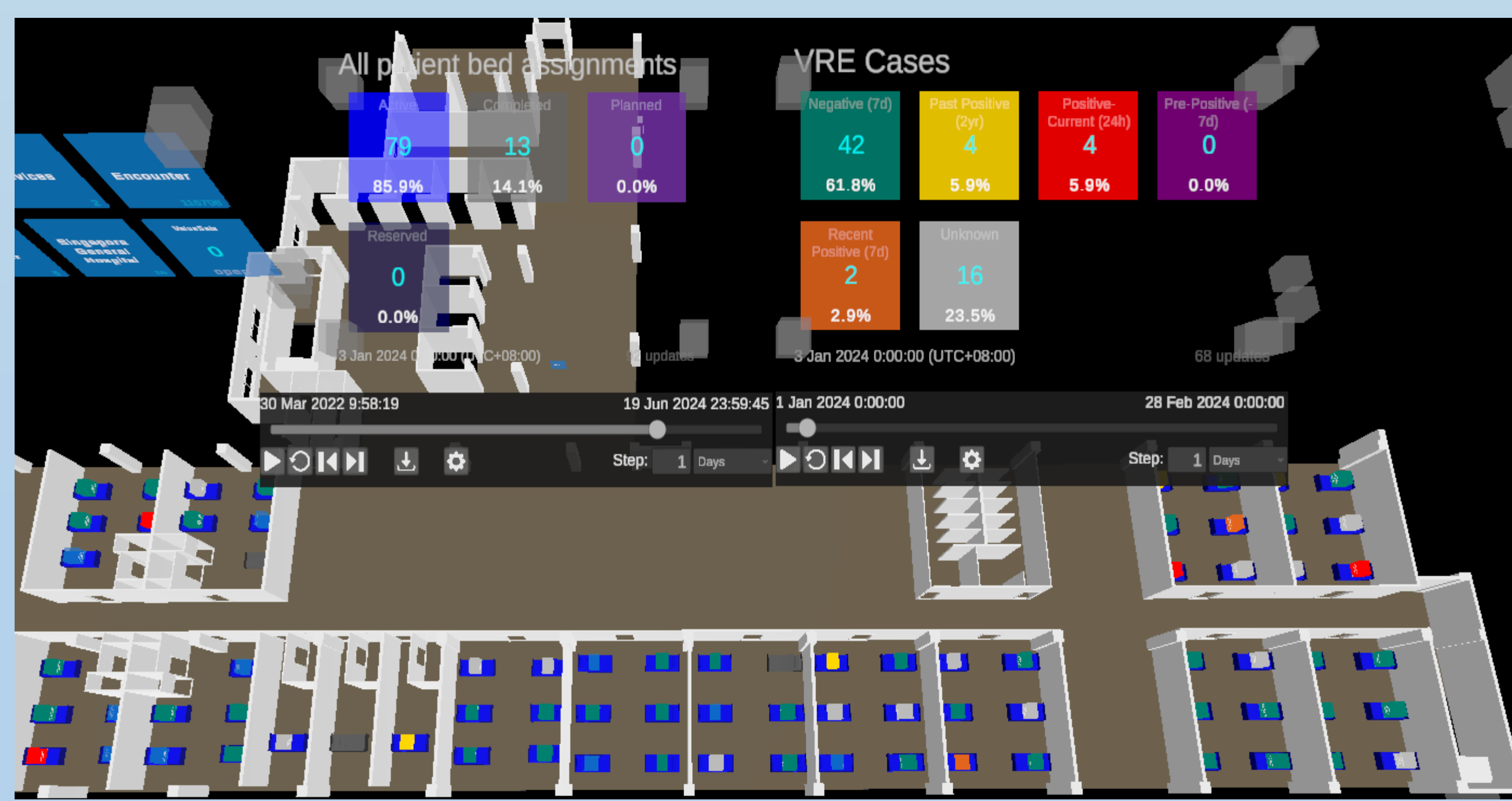


Figure 2: Spatiotemporal distribution of VRE positive patients in the general ward (red color), showing surrounding patients as primary contacts

### 5. CONCLUSION

- We have demonstrated that 4D-DOSS can efficiently perform automated contact tracing and spatiotemporal outbreak mapping.
- The system can be configured for various infectious diseases, thereby supporting outbreak preparedness, early infection prevention interventions, dynamic surveillance requirements and overall patient safety.