CLAIMS

1. A method of determining occupancy in a space, the method comprising:

obtaining data representing one or more device statuses and/or environmental measurements from two or more devices located within the space, wherein the two or more devices (1) include one or more user devices, one or more sensors, or a combination thereof and (2) operate in or observe corresponding areas that at least partially overlap each other;

grouping the data according to data categories representing types of the devices that provided the statuses and/or the measurements;

based on the grouped data, calculating an occupancy estimate for each of the groupings; and

determining an occupancy count based on selectively combining the occupancy estimate of two or more of the groupings, wherein the occupancy count represents the occupancy for a monitored zone in the space.

2. The method of claim 1, wherein:

the data categories include at least a first category and a second category, wherein the first category represents data from devices associated with individual occupants and the second category represents data from public or zone related devices; and

determining the occupancy count includes combining the data corresponding to different types of devices within and/or across the first category and the second category.

3. The method of claim 2, wherein:

grouping the data includes deriving a data subset corresponding to the first category, wherein the data subset includes data representing presence of one person or one object for each of reporting devices; and

determining the occupancy count includes:

calculating one or more reporting-device counts according to one or more device types represented in the data subset; and

determining the occupancy count based on determining a maximum count from the reporting-device counts for the data subset.

4. The method of claim 2, wherein:

grouping the data includes:

deriving a data subset corresponding to the second category, wherein the data subset includes primary data and secondary data derived according to a response time threshold that represents a limit associated with a delay between a change in occupancy and reported data; and

determining the occupancy count includes determining an estimated count based on the primary data and the secondary data.

5. The method of claim 4, wherein determining the estimated count includes:

storing the secondary data collected over a duration; and

determining the estimated count based on the primary data when the stored secondary data remains within one or more corresponding threshold ranges that represent unchanged occupancy.

6. The method of claim 4, further comprising:

determining a maximum capacity representative of the monitored zone;

wherein determining the estimated count includes:

storing the secondary data collected over a duration; and

determining the estimated count based on the stored secondary data when the stored secondary data exceeds one or more corresponding threshold ranges that represent a change in occupancy.

7. The method of claim 6, wherein determining the estimated count includes scaling the maximum capacity with a scale factor that is selected based on comparing the secondary data to one or more environmental reading thresholds.

8. The method of claim 2, wherein:

grouping the data includes:

deriving a first data subset corresponding to the first category, and

deriving a second data subset corresponding to the second category; and

determining the occupancy count includes:

calculating a first estimated count based on the first data subset,

calculating a second estimated count based on the second data subset, and

determining the occupancy count as a greater of the first estimated count and the second estimated count.

9. The method of claim 2, wherein the data categories include at least a third category that represents data from further instances of public or zone related devices configured to estimate the occupancy count, wherein the second category represents data from environmental sensors and the third category represents data having greater sensitivity than the second category in estimating the occupancy count.

10. The method of claim 9, wherein:

grouping the data includes deriving a data subset corresponding to the third category, wherein the data subset includes one or more device-estimated occupancies that each represent a number of persons and/or objects detected by corresponding reporting device; and

determining the occupancy count includes determining the occupancy count based on summing the device-estimated occupancies.

11. The method of claim 9, further comprising identifying uncovered regions associated with the third category based on a map that represents at least the monitored zone, the uncovered regions representing portions in the monitored zone that are unobserved by the two or more devices, and wherein:

grouping the data includes:

deriving a first data subset based on computing device locations relative to the uncovered regions, wherein the device locations represent locations of one or more devices that are associated with the first category, and

deriving a third data subset corresponding to the third category; and

determining the occupancy count includes:

determining an uncovered-device quantity based on comparing the device locations to the uncovered regions,

calculating a third estimated count based on the third data subset, and

determining the occupancy count based on combining the uncovered-device quantity and the third estimated count.

12. The method of claim 9, wherein:

grouping the data includes:

deriving a second data subset corresponding to the second category,

deriving a third data subset corresponding to the third category; and

determining the occupancy count includes:

calculating a third estimated count based on the third data subset, and

determining the occupancy count based selecting the third estimated count over the second data subset.

13. The method of claim 9, further comprising:

identifying uncovered regions associated with the third category based on a map that represents at least the monitored zone, wherein the uncovered regions represent portions in the monitored zone that are unobserved by the two or more devices;

computing device locations relative to the uncovered regions, wherein the device locations represent locations of one or more devices that are associated with the first category;

wherein:

grouping the data includes:

deriving a first data subset based on computing device locations relative to the uncovered regions, wherein the device locations represent locations of one or more devices that are associated with the first category,

deriving a second data subset corresponding to the second category,

deriving a third data subset corresponding to the third category; and

determining the occupancy count includes:

determining an uncovered-device quantity based on comparing the device locations to the uncovered regions,

calculating a third estimated count based on the third data subset, and

updating the third estimated count based on adding the uncovered-device quantity; and

selecting the third estimated count over the second data subset.

14. The method of claim 1, wherein the occupancy count represents a number of objects located within the monitored zone.

15. The method of claim 1, wherein:

the obtained data represents outputs from a thermal sensor, a presence sensor, a motion sensor, a line-crossing sensor, a position locator, a user device, an accelerometer, a magnetometer, a gyroscope, a capacitive sensor, a passive infrared (PIR) device, a radar, a lidar, a mmWave sensor, an infrared transmitter-receiver device, an ultrasonic sensor, a camera, a microphone, a humidity sensor, a gas sensor, a particle sensor, or a combination thereof; and

the occupancy count represents a number of people or a number of objects within the monitored zone.

16. The method of claim 15, further comprising:

identifying the monitored zone representing an open space associated with multiple persons or multiple objects within the space;

wherein determining the occupancy count includes:

identifying key data representing status reported by each of presence sensors that are each physically attached to a desk or a chair located in the open space, and

determining the occupancy count based on the key data.

17. The method of claim 15, further comprising:

identifying the monitored zone representing a conference room within the space;

wherein determining the occupancy count includes:

identifying key data representing statuses reported by presence sensors and/or PIR devices each physically attached to a chair located in the conference room, and

determining the occupancy count based on the key data.

18. The method of claim 1, further comprising:

identifying monitored zones based on a map, wherein the monitored zones represent different spaces within the space;

computing device locations representing locations of one or more devices within the space and reporting the obtained data;

grouping the data according to the corresponding device locations and the monitored zones; and

wherein:

determining the occupancy count includes determining the occupancy count for each of the monitored zones based on the grouped data associated with corresponding monitored zone.

19. The method of claim 1, wherein:

the obtained data includes time stamps;

grouping the obtained data according to the time stamps for synchronizing the data obtaining from multiple devices; and

determining the occupancy count includes determining the occupancy count for a time based on the synchronized data.

20. A tangible, non-transient computer-readable medium having processor instructions encoded thereon that, when executed by one or more processors, configures the one or more processors to:

obtain data representing one or more device statuses and/or environmental measurements from two or more devices located within a space, wherein the two or more devices (1) include one or more user devices, one or more sensors, or a combination thereof and (2) operate in or observe corresponding areas that at least partially overlap each other;

group the data according to data categories representing types of the devices that provided the status and/or the measurement data, wherein the data categories include at least:

a first category that represents data from devices associated with individual occupants, and

a second category that represents data from public or zone related devices; and

determine an occupancy count based on:

calculating a first result based on the data corresponding to the first category,

calculating a second result based on the data corresponding to the second category, and

determining the occupancy count based on combining the first result and the second result, wherein the occupancy count represents the occupancy for a monitored zone in the space.

21. The non-transient computer-readable medium of claim 20, wherein the processor instructions configure the one or more processors to:

group the data based on deriving a data subset corresponding to the first category, wherein the data subset includes data representing presence of one person or one object for each of reporting devices; and

determine the occupancy count based on:

calculating one or more reporting-device counts according to one or more device types represented in the data subset; and

determining the occupancy count based on determining a maximum count from the reporting-device counts for the data subset.

22. The non-transient computer-readable medium of claim 20, wherein the processor instructions configure the one or more processors to:

group the data based on deriving a data subset corresponding to the second category, wherein the data subset includes primary data and secondary data derived according to a response time threshold that represents a limit associated with a delay between a change in occupancy and reported data; and

determine the occupancy count based on determining an estimated count based on the primary data and the secondary data.

23. The non-transient computer-readable medium of claim 20, wherein the processor instructions configure the one or more processors to:

group the data based on:

deriving a first data subset corresponding to the first category, and

deriving a second data subset corresponding to the second category; and

determine the occupancy count based on:

calculating a first estimated count based on the first data subset,

calculating a second estimated count based on the second data subset, and

determining the occupancy count as a greater of the first estimated count and the second estimated count.

24. The non-transient computer-readable medium of claim 20, wherein the data categories include at least a third category that represents data from further instances of public or zone related devices configured to estimate the occupancy count, wherein the second category represents data from environmental sensors and the third category represents data having greater sensitivity than the second category in estimating the occupancy count.

25. A system for determining occupancy in a space, the system comprising:

at least one computer-based processor; and

at least one computer-based memory operably coupled to the computer-based processor and having stored thereon instructions executable by the computer-based processor to cause the computer-based processor to:

obtain data representing one or more device statuses and/or environmental measurements from two or more devices located within the space, wherein the two or more devices (1) include one or more user devices, one or more sensors, or a combination thereof that correspond to one or more monitored zones and (2) operate in or observe corresponding areas that at least partially overlap each other;

group the data according to the monitored zones and data categories that represent types of the devices that provided the statuses and/or the measurements;

based on the grouped data, calculate an occupancy estimate for each of the groupings; and

determine an occupancy count based on selectively combining the occupancy estimate of two or more of the groupings, wherein the occupancy count represents the occupancy for one of the monitored zones in the space.

26. The system of claim 25, wherein:

the data categories include at least a first category and a second category, wherein the first category represents data from devices associated with individual occupants and the second category represents data from public or zone related devices; and

the at least one computer-based memory includes instructions to cause the computer-based processor to determine the occupancy count based on combining the data corresponding to different types of devices within and/or across the first category and the second category.

27. The system of claim 25, wherein the at least one computer-based memory includes instructions to cause the computer-based processor to:

identify monitored zones based on a map, wherein the monitored zones represent different spaces within the space;

compute device locations representing locations of one or more devices within the space and reporting the obtained data;

group the data according to the corresponding device locations and the monitored zones; and

wherein:

the occupancy count is determined for each of the monitored zones based on the grouped data associated with corresponding monitored zone.