# Tracking Inpatient Infections with GIS

2007 ESRI Health GIS Conference

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# Acknowledgements

- Jeff Wilson
- Kelly Johnston
- Steve Wilson

- Regenstrief Institute, Inc.
- Clement McDonald

- ESRI

# GIS in Healthcare

- Geography increasingly recognized
  - Medline "GIS" or "Geographic Information Systems"
    - 2000-2003 = 616
    - 2006-2007 = 627
- Primarily community/regional level analysis
  - Environmental risk / Exposures
  - Disease distributions

# Hypotheses

- Adapt GIS techniques from community level to hospital level

- Simplify the linking and interpretation of multiple data sources

# A Worsening Problem

- Hospital acquired infections – 2,000,000 / year



- 90,000 patient deaths / year[1]

- Increasing Antibiotic Resistance
  - **MRSA**- Methicillin-Resistant Staphylococcus aureus
    -57.1% of S. aureus isolates in ICUs[2]
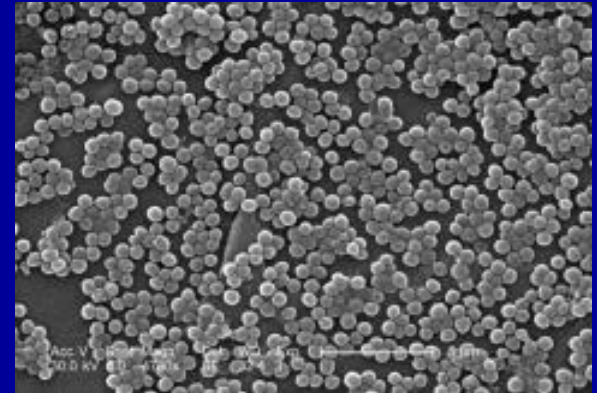
[1]MMWR Morbidy and Mortality Weekly Report. 1992;41:783-7

[2]Am J Infect Control 2003;31:481-498

# Combatting the problem

- Infection Control Providers
  - Hand Hygiene
  - Contact Isolation
  - Active Surveillance

  - Outbreak Investigation

10 AUG 04    10:22AM
19 Patients for : 5N
Total acuity = 57    Avg acuity = 3.16

| Patient Name | Hosp# | Bed Num | Admit Date | Acuity | Age | Pending Ords |
|---|---|---|---|---|---|---|
| T████, B████  ████9-0 | W5110A✓ | | N/A | 4 | 50yr | Pend disch ord on 09 AUG 04 at 12:17PM |
| K████, A████ E ████6-7 | W5111A✓ | 09 AUG 2004 | | 1 | 69yr | |
| R████████, W████ 9-3 | W5112A✓ | | N/A | 2 | 60yr | |
| D████, T████ JE ████3-2 | W5113A✓ | 07 AUG 2004 | | N/A | 54yr | Pend disch ord on 08 AUG 04 at 09:31AM |
| M████, A████ ████5-0 | W5114B | 04 AUG 2004 | | 4 | 74yr | Pend disch ord on 06 AUG 04 at 02:16PM |
| R████, L████ ████7-6 | W5115A | 05 AUG 2004 | | 3 | 75yr | |
| | | | N/A | 3 | 79yr | Pend disch ord on 07 AUG 04 at 08:22AM |
| | | | N/A | 5 | 62yr | |
| | | | N/A | 3 | 56yr | Pend disch ord on 07 AUG 04 at 12:54AM |

| DATE | SOURCE | NAME | MRN# |
|---|---|---|---|
| 04/18/1999 | URINE | A*****, C**** | *******3 |
| 01/27/1998 | URINE | A****, L****** | ********5 |
| 02/11/1998 | RECTAL SWAB | A**********, M**** | ********9 |
| 11/25/2003 | URINE | A*****,M**** | *********6 |
| 07/28/2003 | URINE | B****,D******* | *********8 |
| 03/19/2003 | URINE | B*****, M******** | ********6 |
| 11/27/2002 | URINE | B******, D*****8 | *******1 |
| 06/6/1998 | BLOOD | B**********, B***** | ********0 |

4725-3)      20-Apr-04      1156      on
Lab ----

LOC: OBGYN          DR. MARTINIE,MARY K

URINE CULTURE          (UC8860-1)      19-Apr-04      1353
              Verified by "JTH" on 20-Apr-04 at 01:14 PM
       SOURCE(S):  urine CCMS
   URN ORG          no growth-final

LOC: 4N          DR. PELTE,CHRISTIAN

AFB CULTURE          (TB0207-6)      12-Apr-04      1330
              Verified by "BAY" on 19-Apr-04 at 12:20 PM
       SOURCE(S):  sputum
          SOURCE TEXT: #1
   AFB SMEAR          AFB none found
   TB ORGANISM        no growth-prelim

# Data overload?

- Infection control
  - One nurse
  - Most of time spent gathering, sorting and linking paper records
  - Little time to investigate outbreaks and educate staff

# A potential solution

- Use a GIS to link disparate data and present data in an intuitive visual format to facilitate tracking of infections, and investigating factors that contribute to outbreaks.

# Design

- Feasibility Study
- Retrospective - Three months
- Four wards

# Methods

- Existing electronic data sources
  - Hospital Floor Plans (CAD drawings)
  - Microbiology Data
  - Admission/Discharge/Transfer (ADT) Data
  - Electronic Orders (Contact Isolation)
- Cleaned, merged, de-identified (MS Access)
- Imported into a GIS for visual presentation
- Laptop
- ArcMap 9.0 with Tracking Analyst
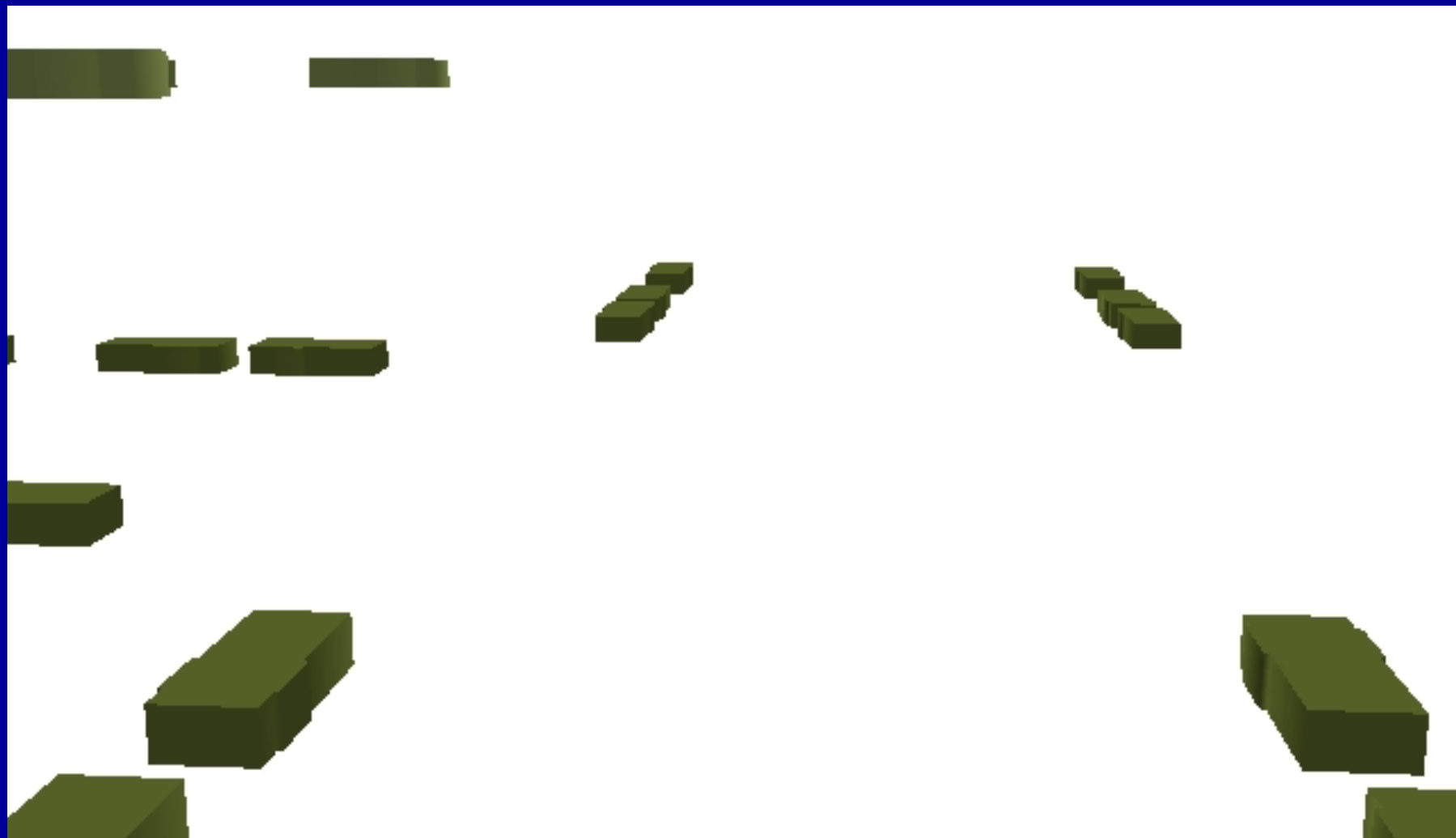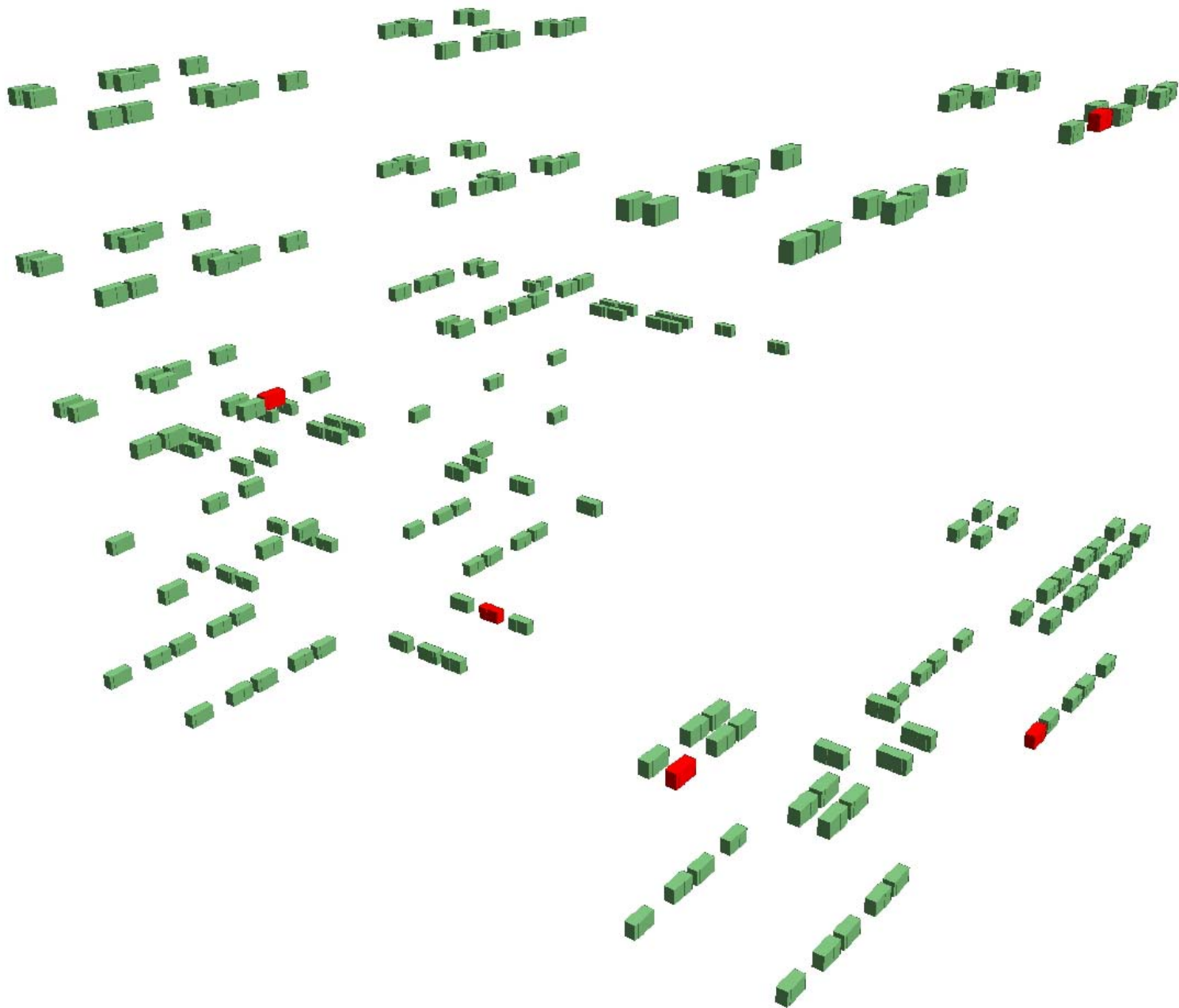
# Example: Patient placement



- 8/42 (19%) MRSA cases

- 67% - No barrier isolation orders

■ = Infected or colonized
■ = Not infected or colonized

# Capturing staff movement

- VitalNet Bedside Computers
- Four Wards
- Date/Time stamped vital signs capture
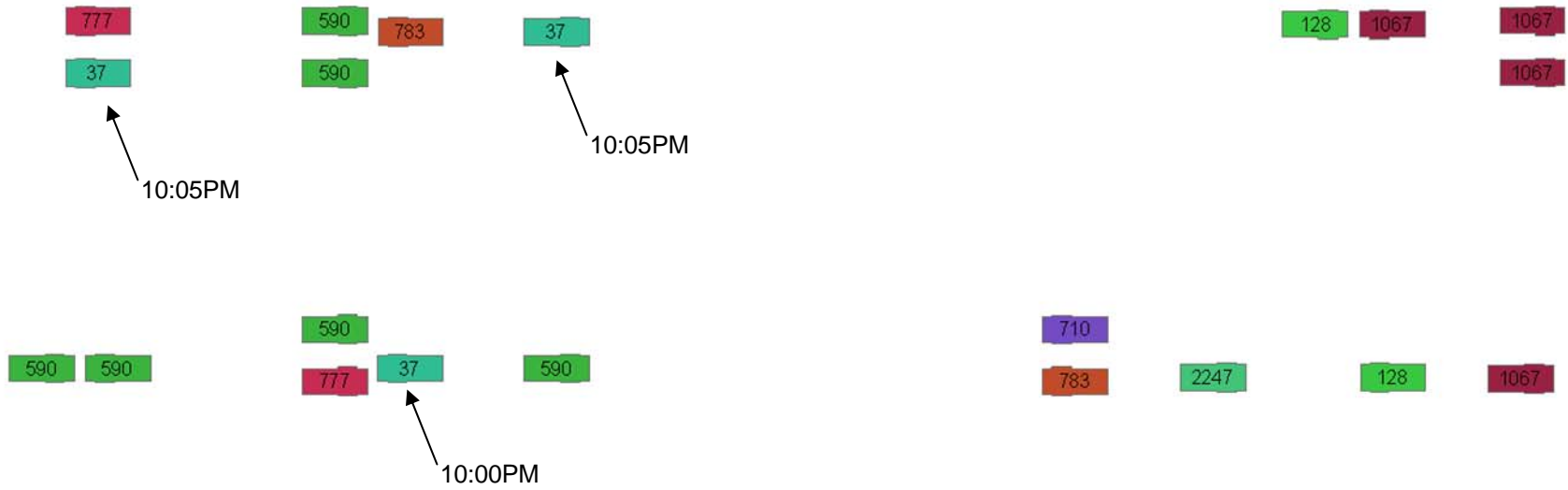- Unique nurse logins
- Documented nurse-patient contacts

777
590
783
590
590
590
128 1067
1067
1067

590
710
590 590
777 37
590
783 2247 128 1067

Watch the activity of practitioner #37

10:05PM

10:05PM
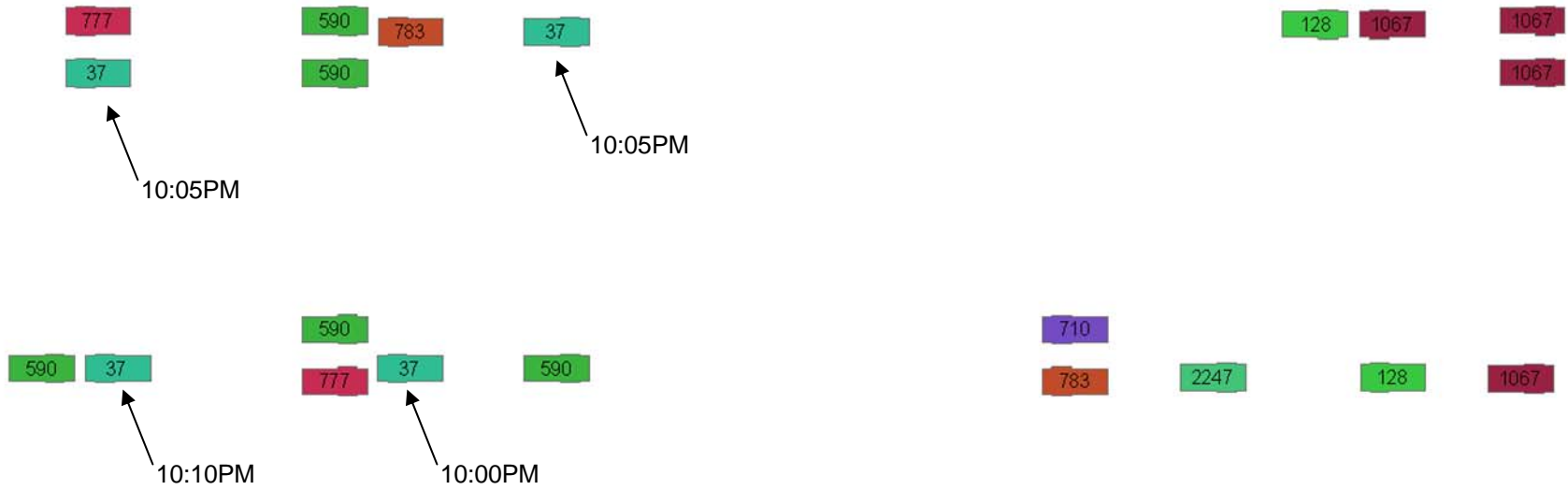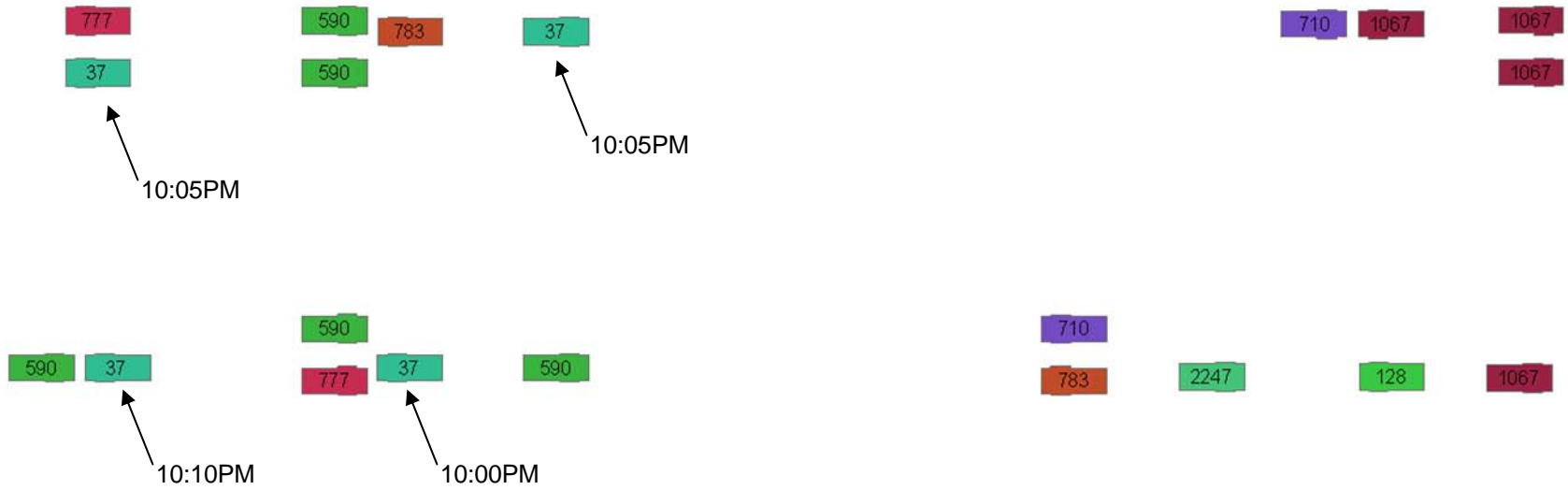
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## 10:00PM-11:30PM

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## 10:00PM-11:30PM

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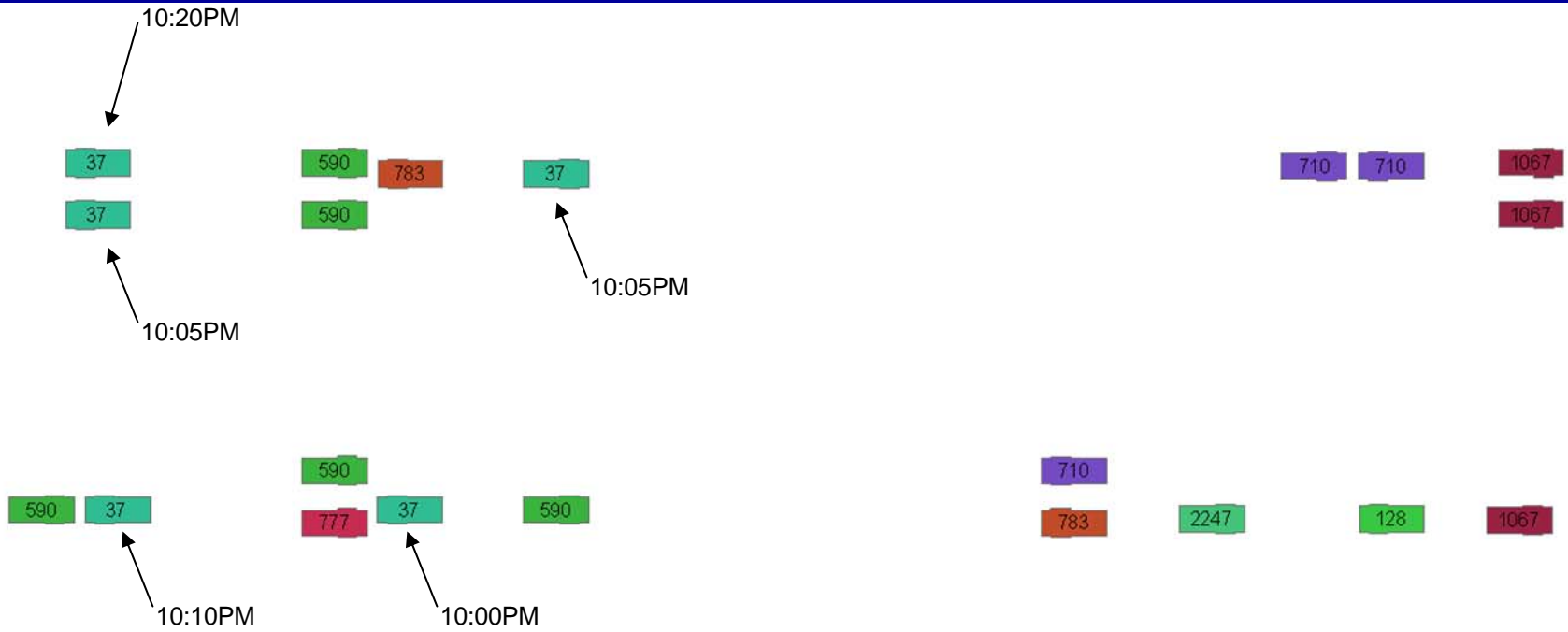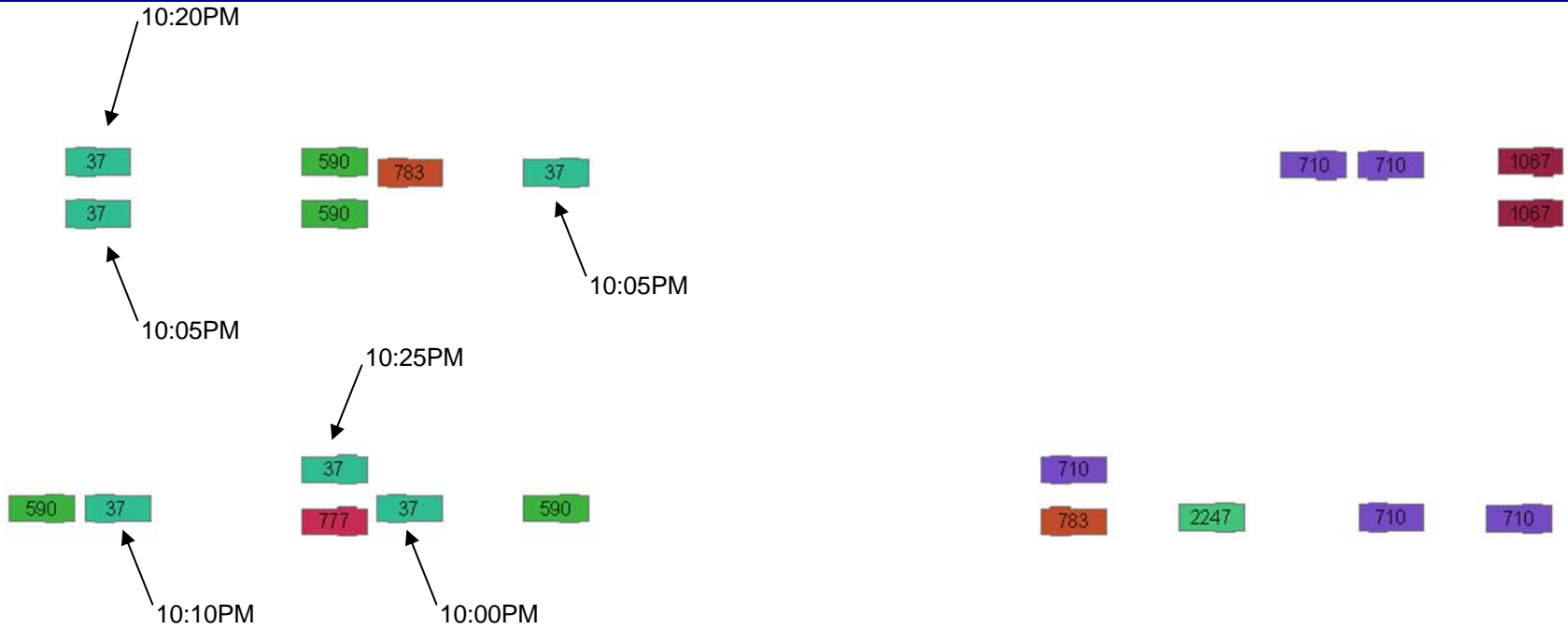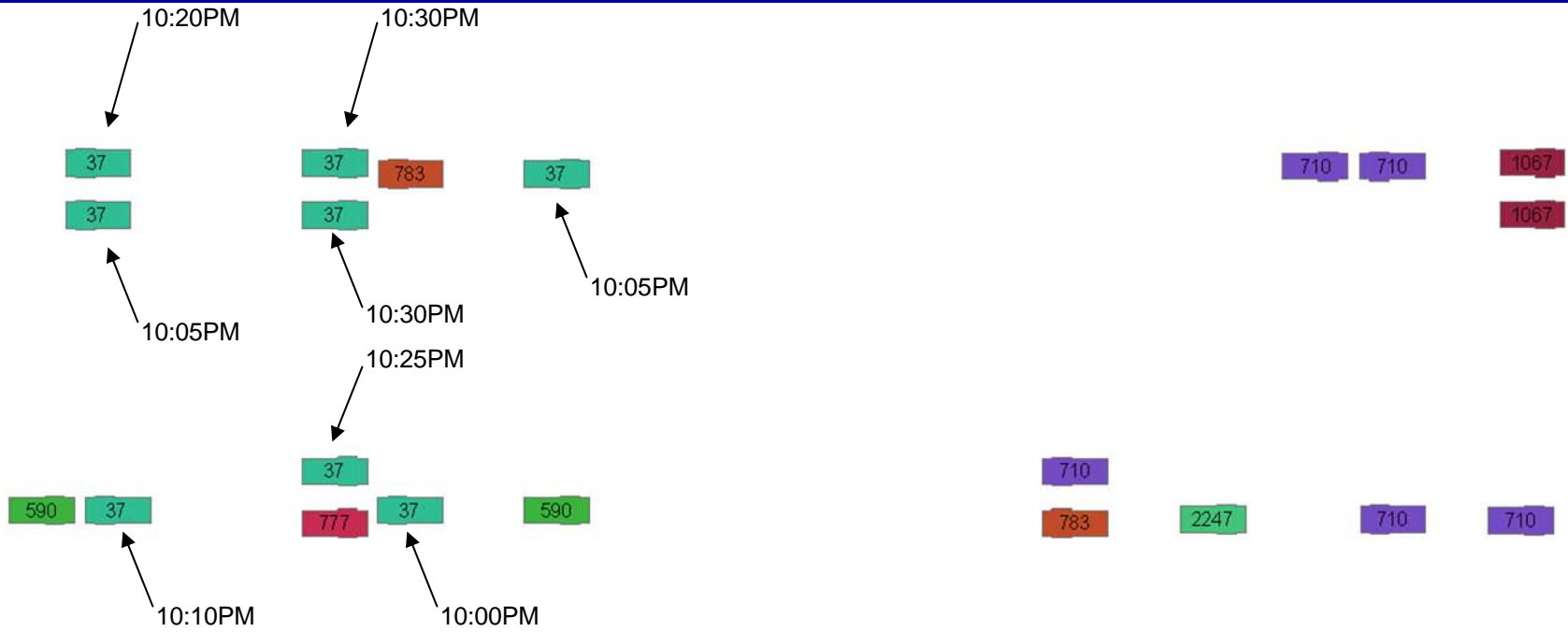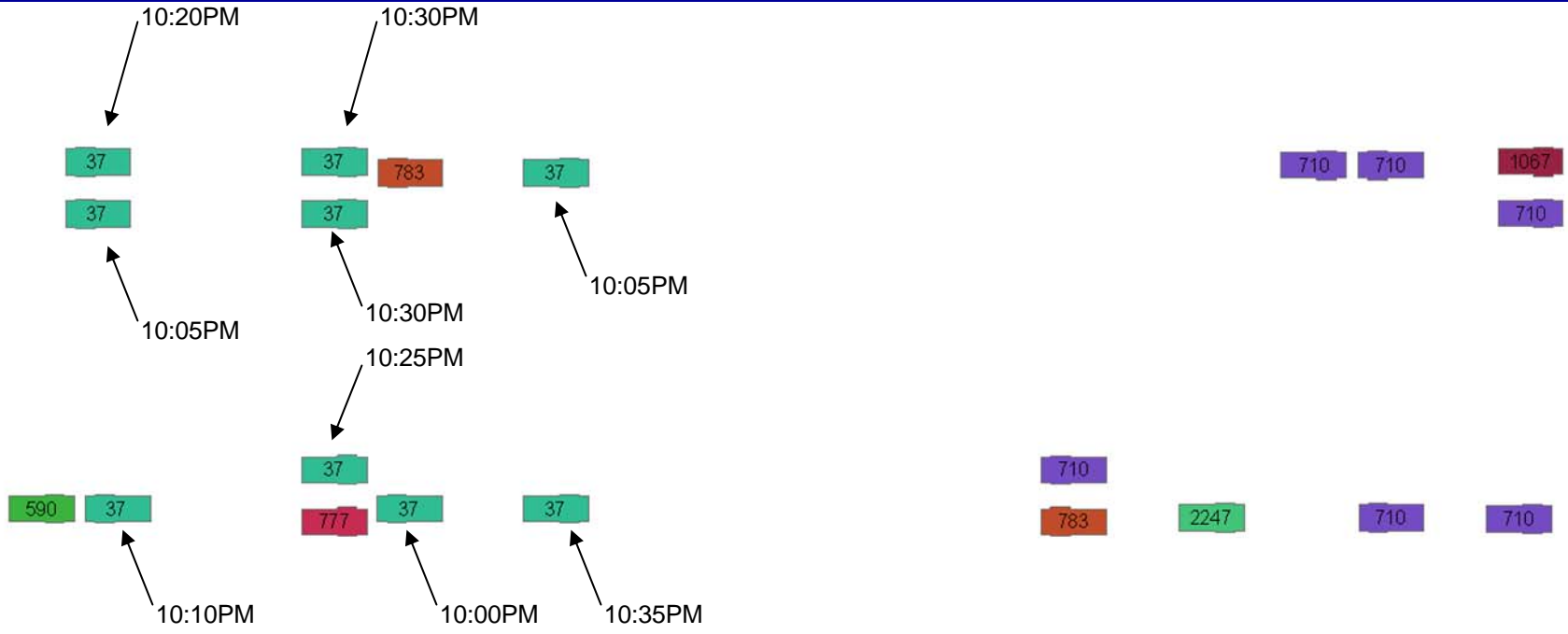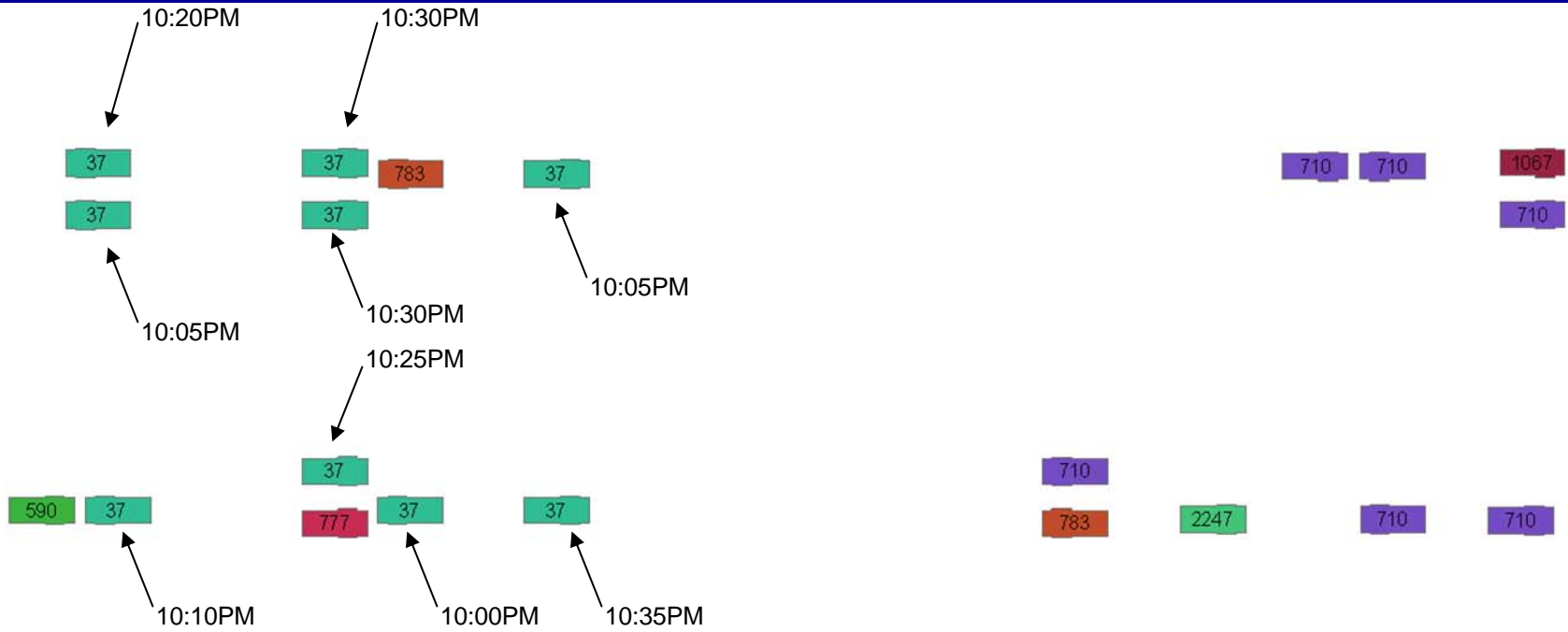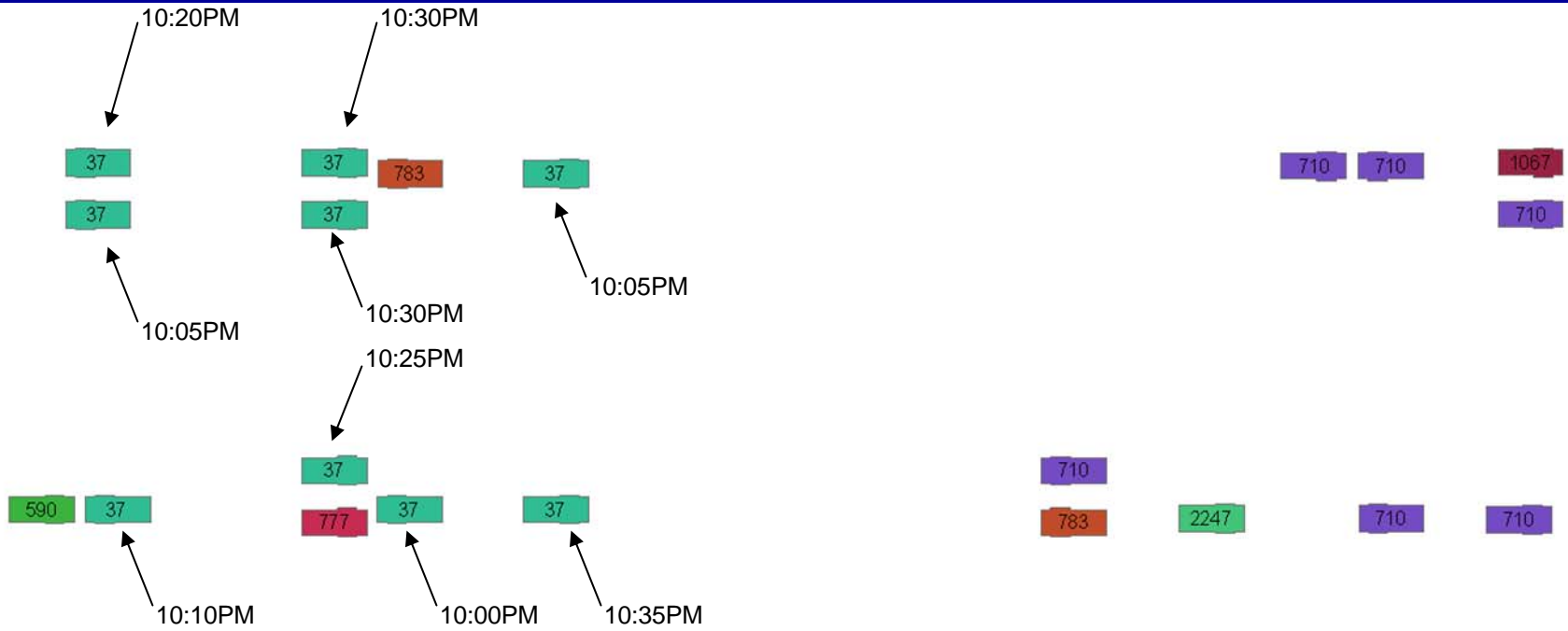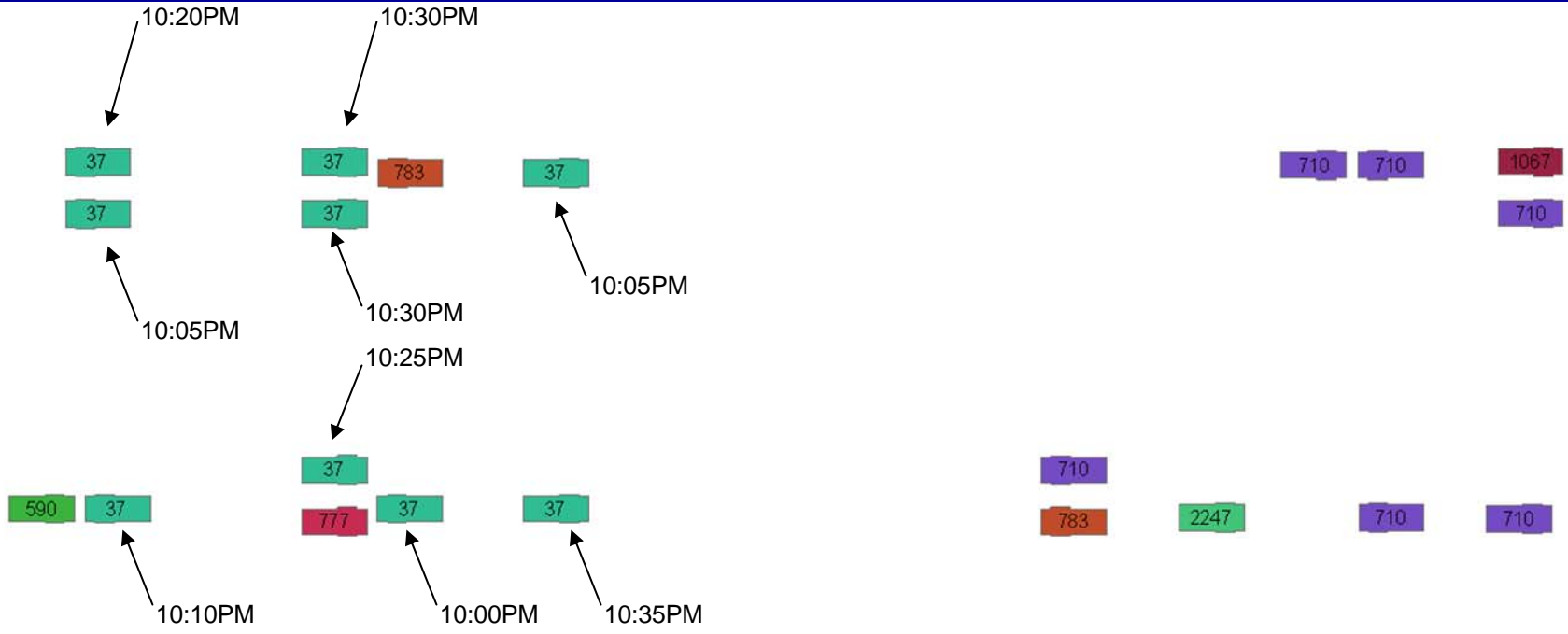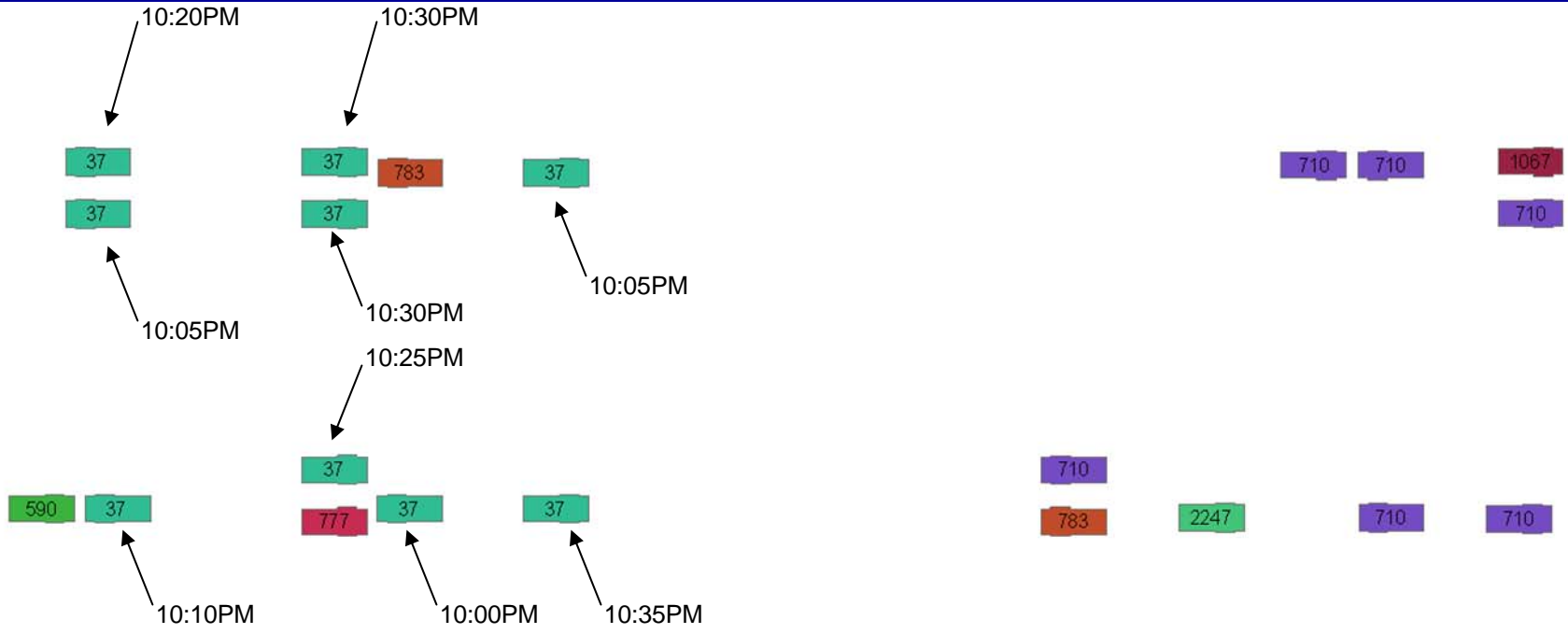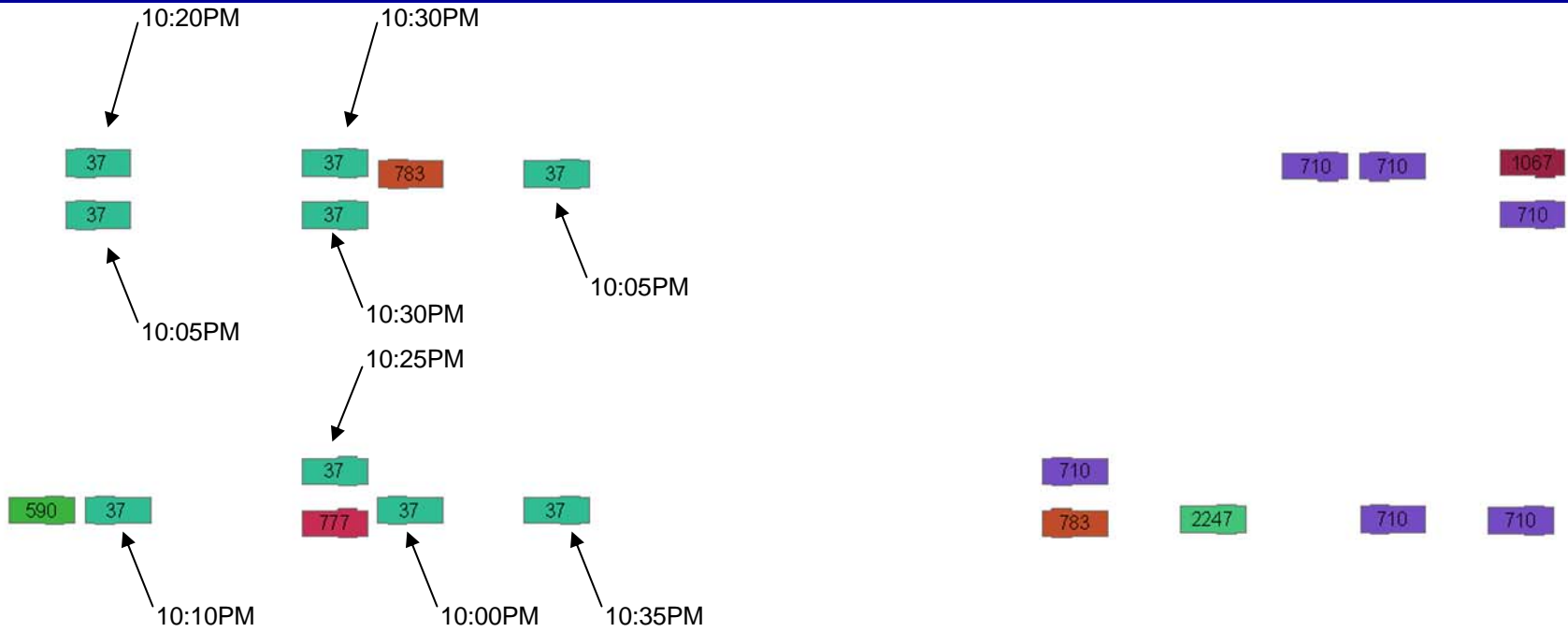
11:05PM    10:10PM    10:00PM    10:35PM
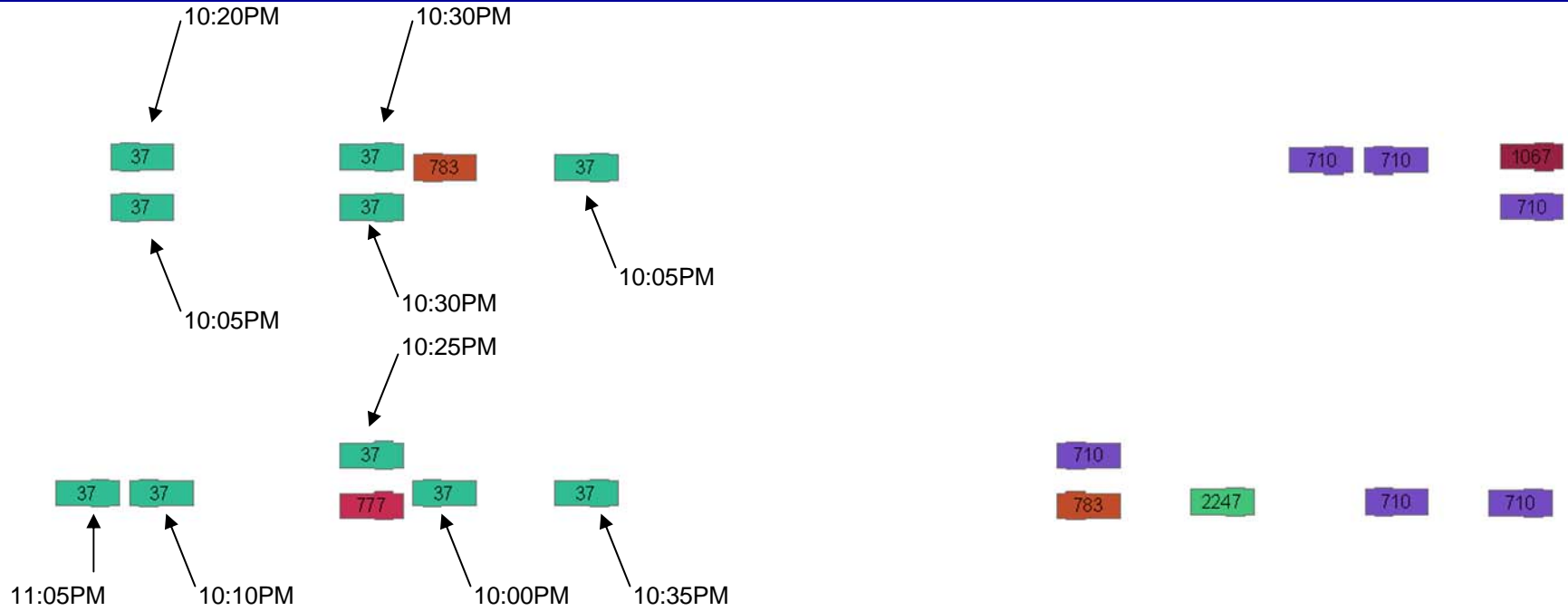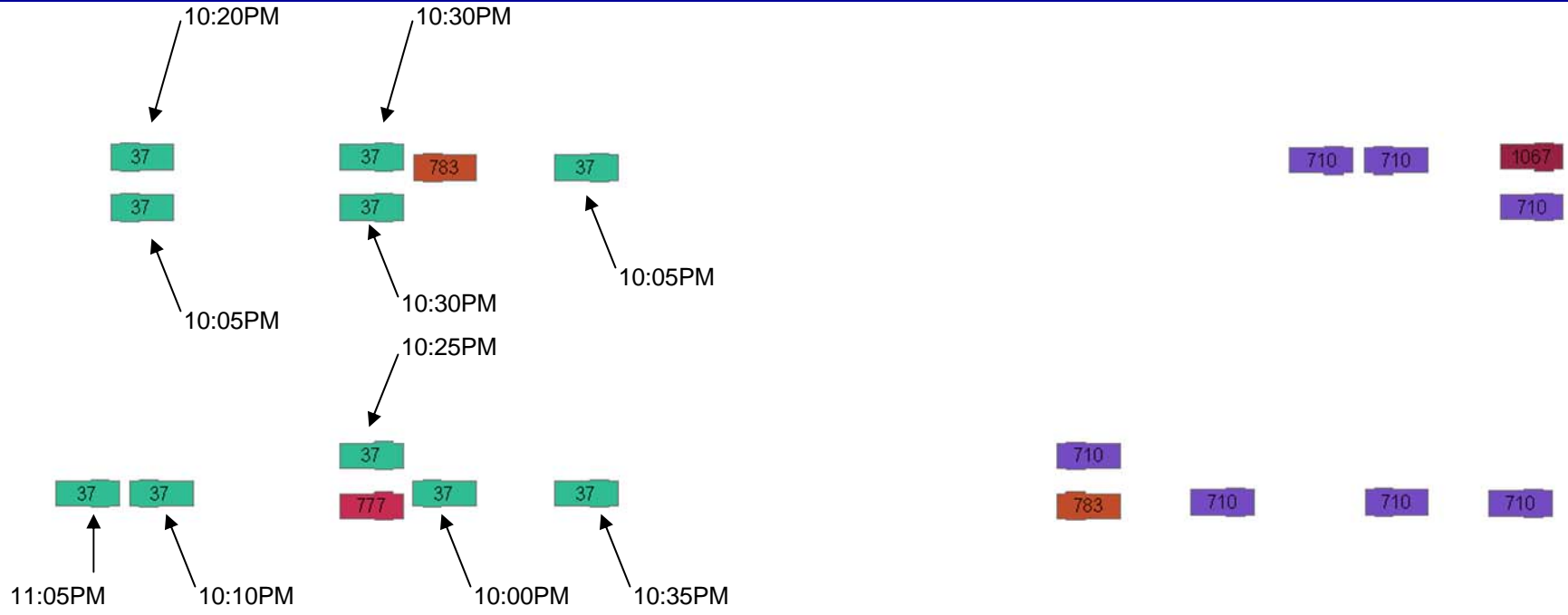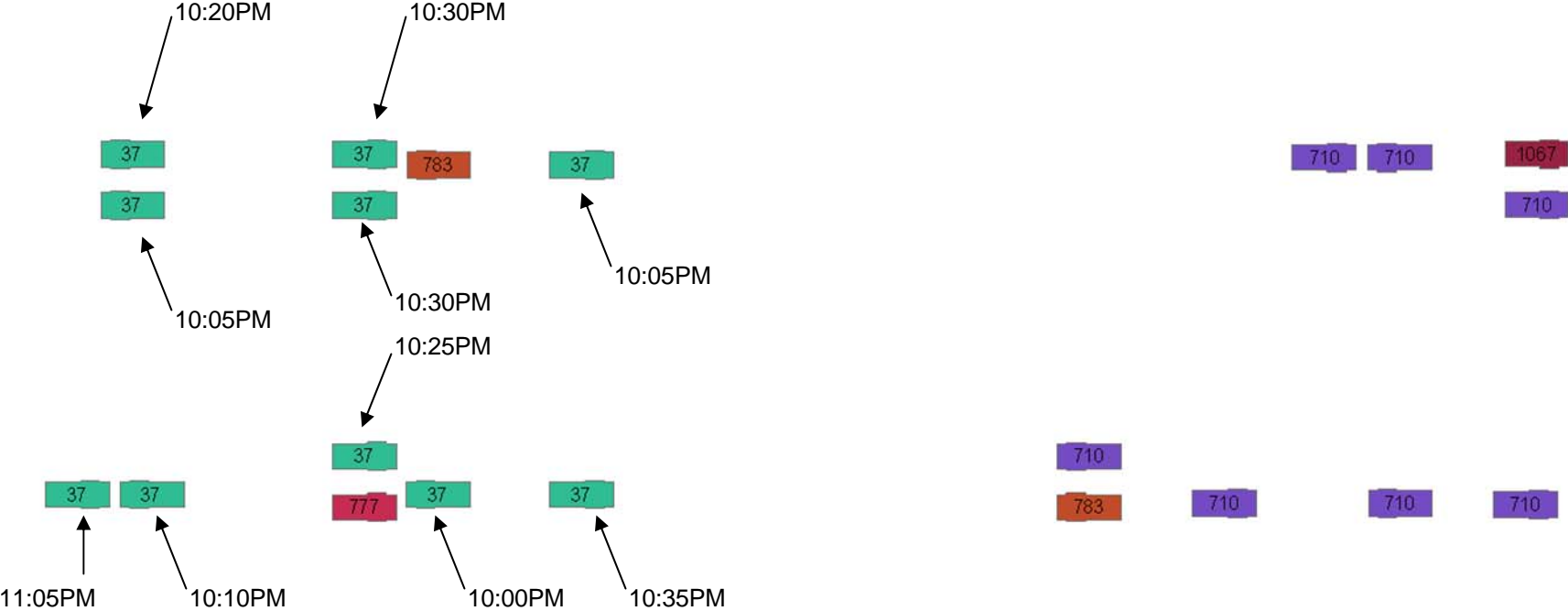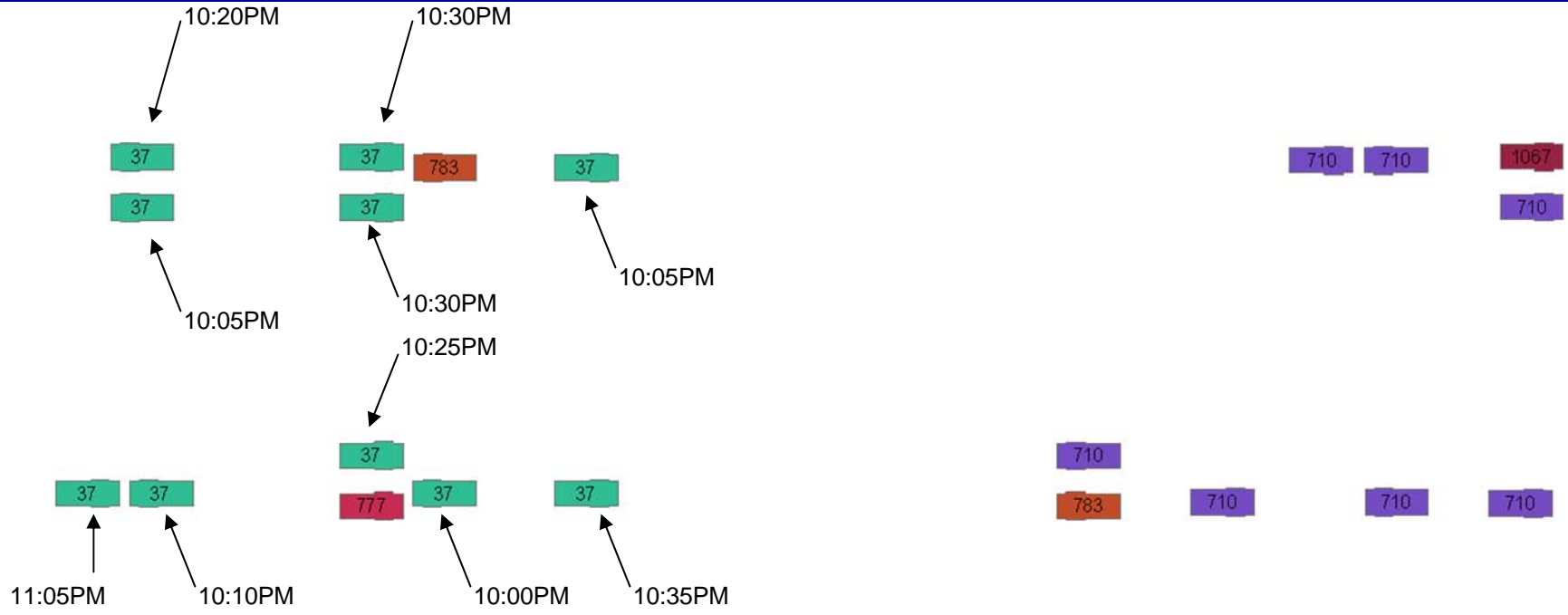
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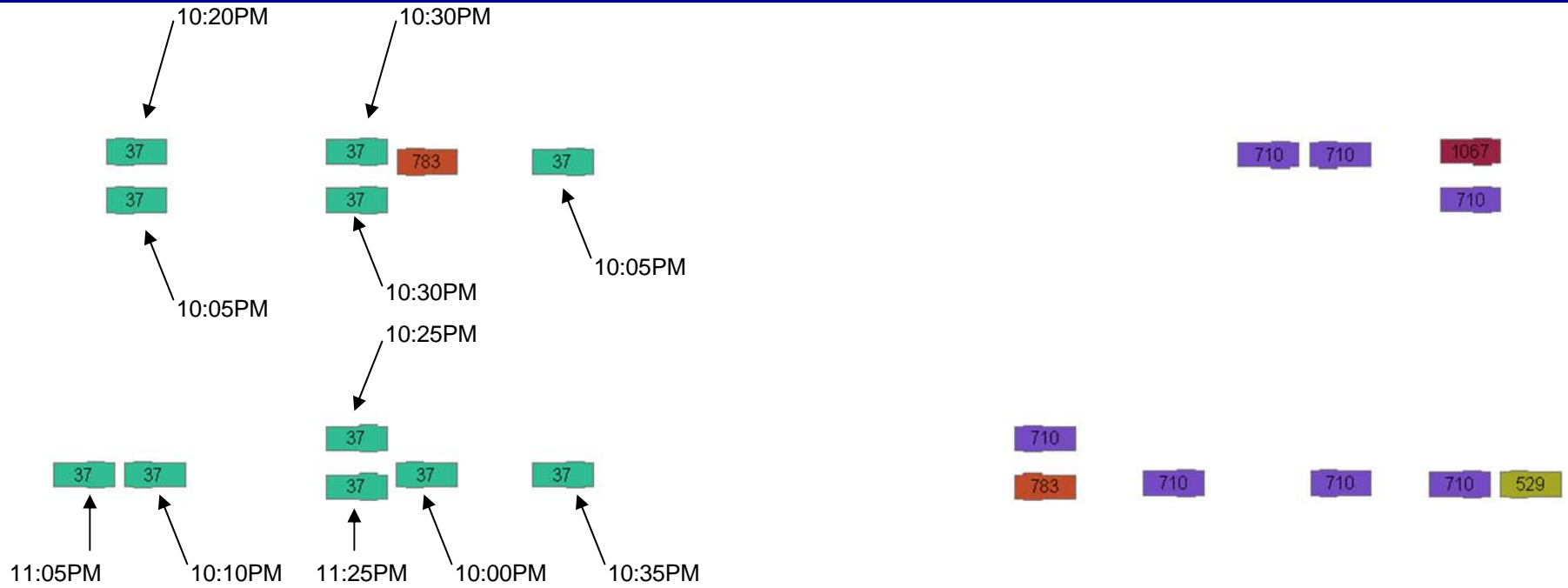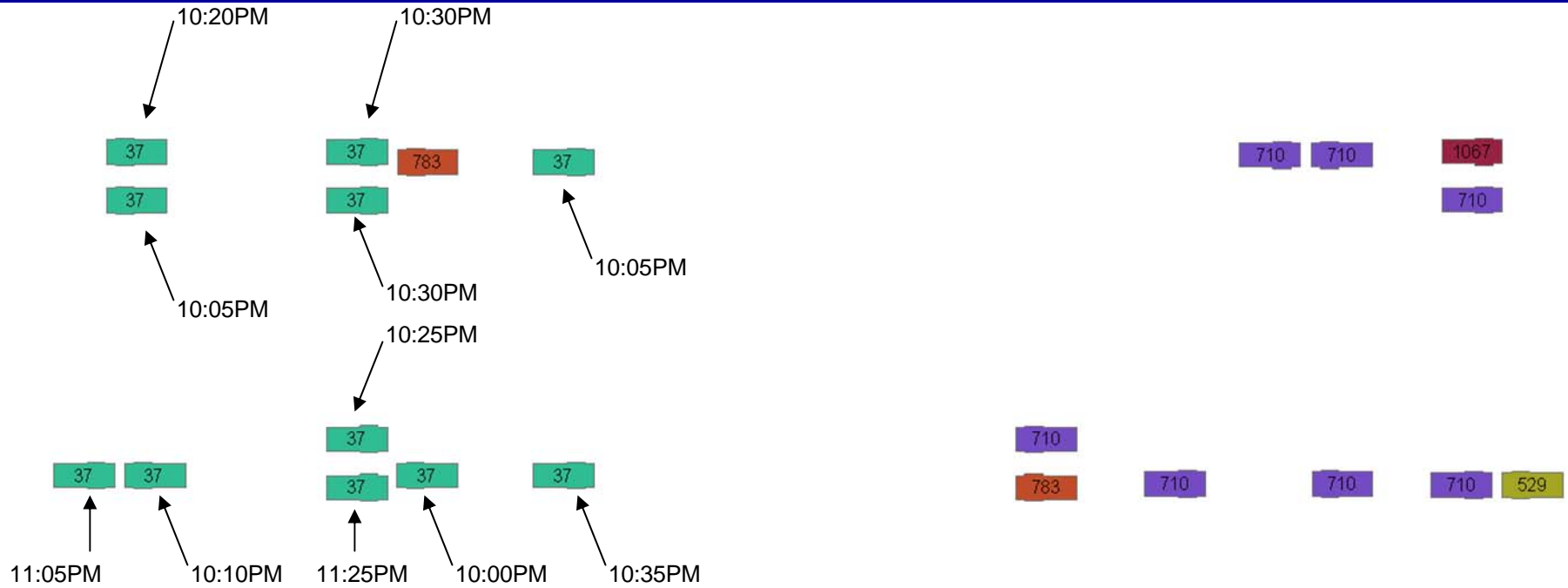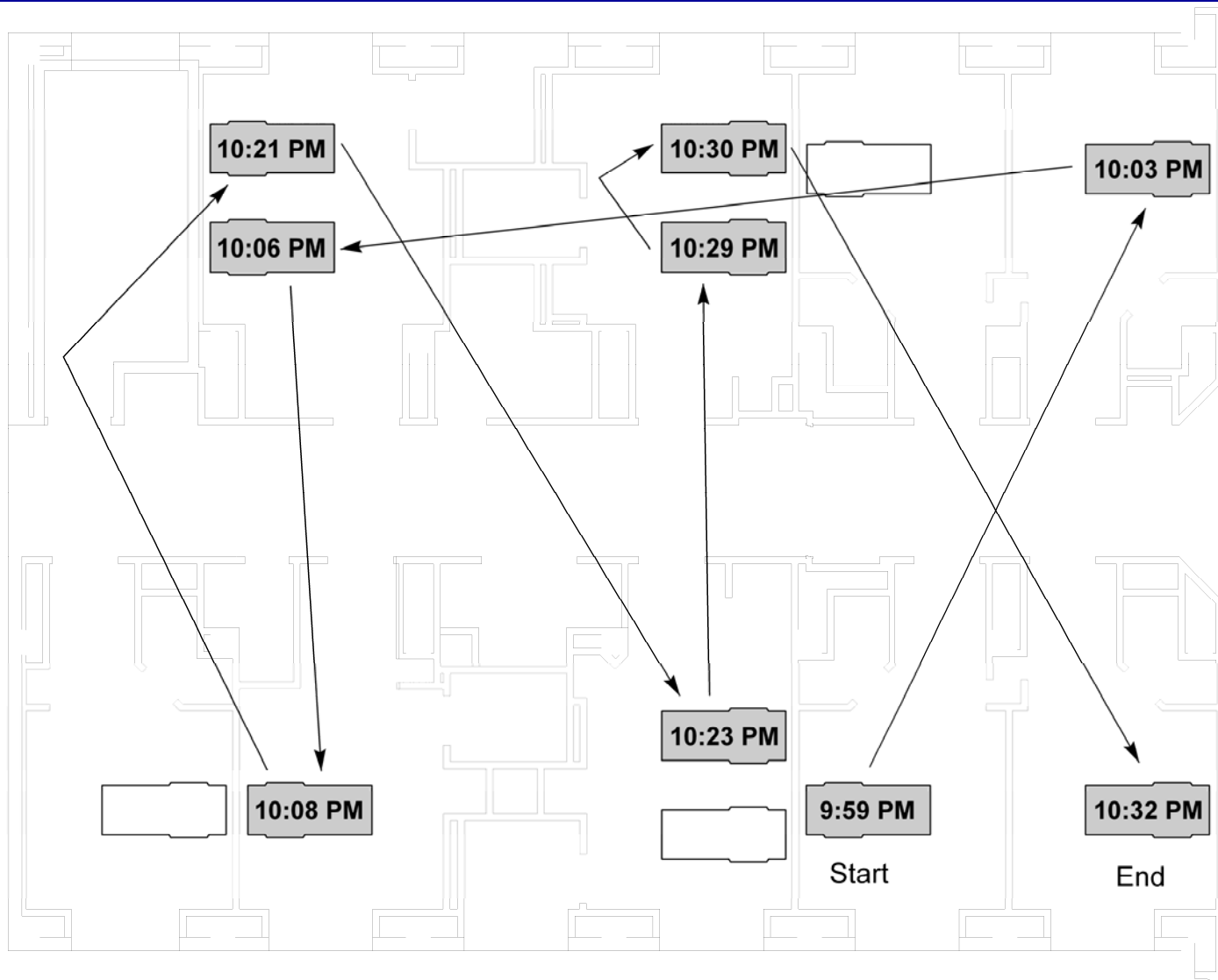
In 35 minutes a single practitioner had documented contact with 9 patients.

# Example: Provider movement

# Results

- 3 months

- Estimate of 3 minutes for adequate hand hygiene

- 6248 times (14% of all documented contacts) = < 3 minutes between contacts

- Mostly due to nursing aides

# Transfer of Vancomycin-Resistant Enterococci via Health Care Worker Hands

Amy N. Duckro, DO; Donald W. Blom, RN; Elizabeth A. Lyle, AB; Robert A. Weinstein, MD; Mary K. Hayden, MD

**Background:** The roles of the contaminated hospital environment and of patient skin carriage in the spread of vancomycin-resistant enterococci (VRE) are uncertain. Transfer of VRE via health care worker (HCW) hands is assumed but unproved. We sought to determine the frequency of VRE transmission from sites in the environment or on patients' intact skin to clean environmental or skin sites via contaminated hands of HCWs during routine care.

**Methods:** We cultured sites on the intact skin of 22 patients colonized by VRE, as well as sites in the patients' rooms, before and after routine care by 98 HCWs. Observers recorded sites touched by HCWs. Cultures were obtained from HCW hands and/or gloves before and after care. All isolates underwent pulsed-field gel electrophoresis. We defined a transfer to have occurred when a culture-negative site became positive with a VRE pulsotype after being touched by an HCW who had the same pulsotype on his or her hands or gloves and who had previously touched a colonized or contaminated site.

**Results:** Health care workers touched 151 negative sites after touching a site that was positive for VRE. Sixteen negative sites (10.6%) became positive after contact. The percentage of times that contact with a site led to a transfer was highest for antecubital fossae and blood pressure cuffs.

**Conclusions:** Vancomycin-resistant enterococci were transferred from contaminated sites in the environment or on patients' intact skin to clean sites via HCW hands or gloves in 10.6% of opportunities. Controlling VRE by decontaminating the environment and patients' intact skin may be an important adjunctive infection control measure.

Arch Intern Med. 2005;165:302-307

- Irrefutable Evidence – EDUCATE!

# Limitations

- Associations, not cause/effect
- Generated a LOT of data

# Conclusions

- Feasible to use a GIS to merge multiple data sources

- Presentation in this simple visual format made previously undetected trends obvious

- Kho AN, Johnston KG, Wilson JS, Wilson SJ. Implementing an Animated Geographic Information System to Investigate Factors Associated with Nosocomial Infections: A Novel Approach.  American Journal of Infection Control 2006;34:578-82 .

# Potential Uses

- Outbreak investigation
- Hospital Design
- Resource management
  - E.g. Room assignment
- Questions: Does your location in the hospital make a difference?
  - Safety (Infections, adverse events)

# Can I do this at home?

- Yes
- "Events"
- Electronically captured/stored
  - Floor plans
  - Admission, Discharge, Transfer messages (ADTs)
  - Login data
  - Orders/Labs

# Related work

Indiana Network for Patient Care (INPC)
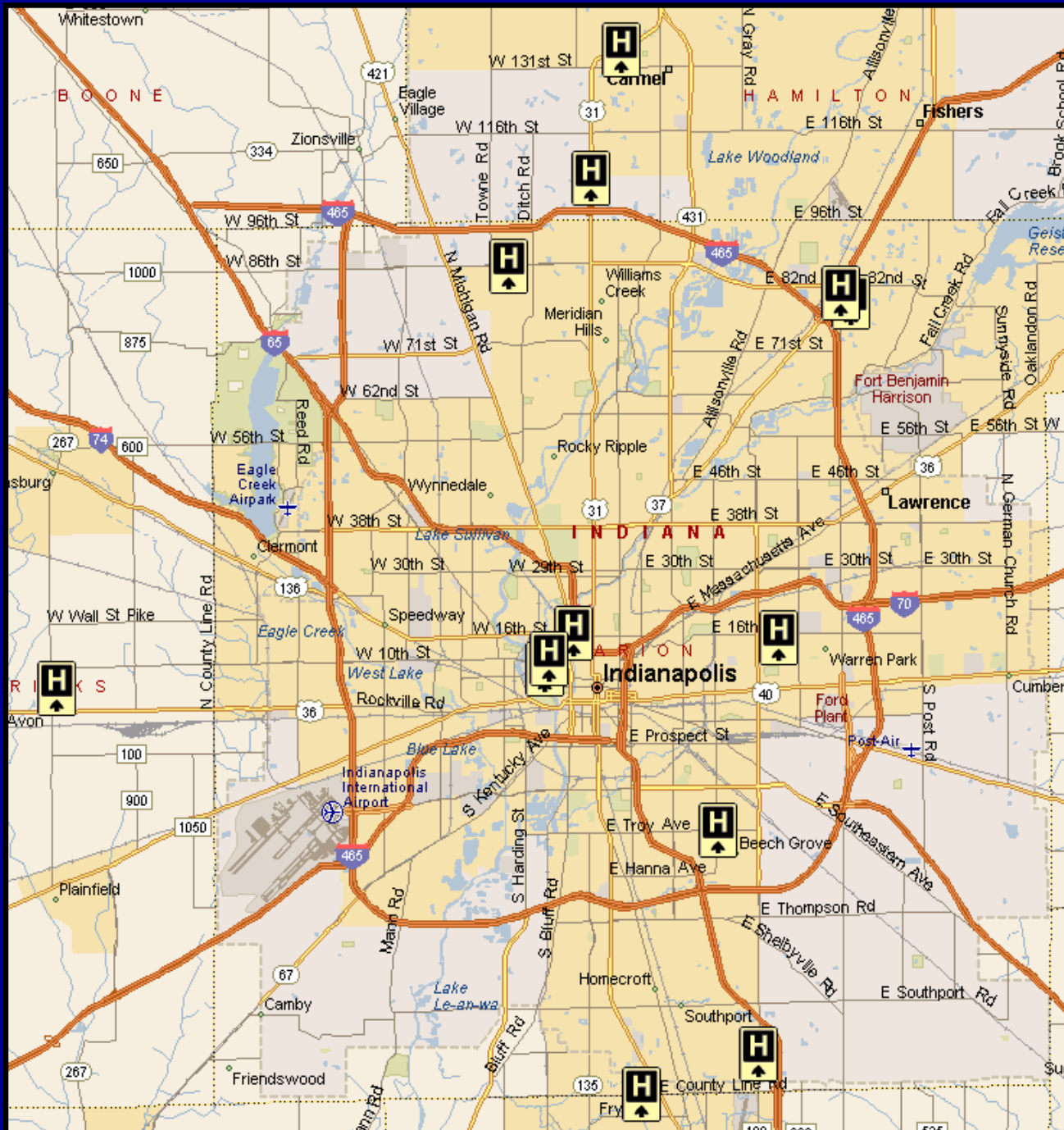
# Ongoing work

- Within the INPC
- >95% of all inpatient care
- >12,000 MRSA cases
- Geocode all of the known MRSA patients in a city

# Citywide MRSA Tracking

| HOSPITAL NAME | TOTAL | COMMUNITY NORTH | COMMUNITY SOUTH | METHODIST HOSP | ST VINCENT HOSP | ST_VINCENT | WISHARD |
|---|---|---|---|---|---|---|---|
| COMMUNITY NORTH | 2 | 1 | | | | 1 | |
| COMMUNITY SOUTH | 1 | | 1 | | | | |

| HOSPITAL NAME | TOTAL | BC | CLARIAN | CLARIAN NORTH | COMMUNITY | COMMUNITY EAST | COMMUNITY HEART | COMMUNITY NORTH | COMMUNITY SOUTH | IU HOSPITAL | METHODIST HOSP | RE | RILEY | ST FRANCIS HOSP | ST FRANCIS SOTH | ST VINCENT HOSP | ST_FRANCIS | ST_VINCENT | TA | WISHARD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BC | 1 | 1 | | | | | | | | | | | | | | | | | | |
| CLARIAN NORTH | 1 | | | 1 | | | | | | | | | | | | | | | | |
| COMMUNITY EAST | 35 | | 9 | | | 19 | | | | | | | | | | | 2 | 1 | | 4 |
| COMMUNITY HEART | 1 | | | | | | 1 | | | | | | | | | | | | | |
| COMMUNITY NORTH | 30 | | 2 | | | | | 20 | | | | | | | | | 3 | 3 | | 2 |
| COMMUNITY SOUTH | 15 | | 2 | | | | | | 12 | | | | | | | | 1 | | | |
| IU HOSPITAL | 17 | | | | | | | | | 17 | | | | | | | | | | |
| METHODIST HOSP | 20 | | | | | | | | | | 20 | | | | | | | | | |
| RE | 1 | | | | | | | | | | | 1 | | | | | | | | |
| RILEY | 1 | | | | | | | | | | | | 1 | | | | | | | |
| ST FRANCIS HOSP | 9 | | | | 1 | | | | | | | | | 6 | | | | 1 | | 1 |
| ST FRANCIS SOTH | 2 | | | | | | | | | | | | | | 2 | | | | | |
| ST VINCE CARMEL | 1 | | | | 1 | | | | | | | | | | | | | | | |
| ST VINCENT HOSP | 21 | | 2 | | | | | | | | | | | | | 19 | | | | |
| TA | 5 | | | | | | | | | | | | | | | | | | 5 | |
| WISHARD | 65 | | 3 | | | | | | | | | | | | | | | 2 | | 60 |
| **Total** | **225** | **1** | **18** | **1** | **2** | **19** | **1** | **20** | **12** | **17** | **20** | **1** | **1** | **6** | **2** | **19** | **6** | **7** | **5** | **67** |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST VINCENT HOSP | 4 | | | | | | | | | | | | | 3 | | | | | | 1 |
| WISHARD | 17 | 1 | | | | | | | | | | | | | | | 1 | | | 15 |
| **Total** | **61** | **9** | **4** | **6** | **3** | **3** | **6** | **1** | **1** | **1** | **3** | **3** | **2** | **19** | | | | | | |

Kho AN, Dexter PR, Lemmon L, Carey D, Woodward-Hagg H, Hare S, Doebbeling BN. Connecting the Dots: Creation of an Electronic Regional Infection Control Network. Medinfo 2007

# Summary

- GIS can be a useful tool to pull together disparate data sources *within* the hospital setting.

- Opens up opportunity for quality improvement and research

# Thank you!
# Questions?

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