Roll Your Own AVL with ArcGIS Server

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Cad24x7 AVL Overview

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Henrico County, VA

IT Department

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County of Henrico, VA: Profile

- 244 square miles
- Population 310,000
- Police force: 600 members
- Fire and EMS: 22 stations (16 w/EMS)
- Dispatch center:
  - Dispatches Police, Fire and EMS
  - 30 Positions
  - 390,000 calls and unit activities annually

AVL: Automatic Vehicle Location

- AVL: Common name for GPS tracking
- Consists of:
  - Data Collection component
  - Visualization component (map)
  - Proximity based unit recommendations for use with computer aided dispatch.

System Architectures

- Cad24x7 - Henrico County's custom in-house dispatch system
  - HA solution.
  - Uses Network Load Balancing
  - Uses SQL Server mirroring.
  - Deployed over two locations.
  - Redundant network links between
- HenricoGIS – Henrico's ESRI based enterprise GIS system
  - HA Solution
  - Uses Network Load Balancing for ArcGIS server
  - Uses SQL Server active passive cluster

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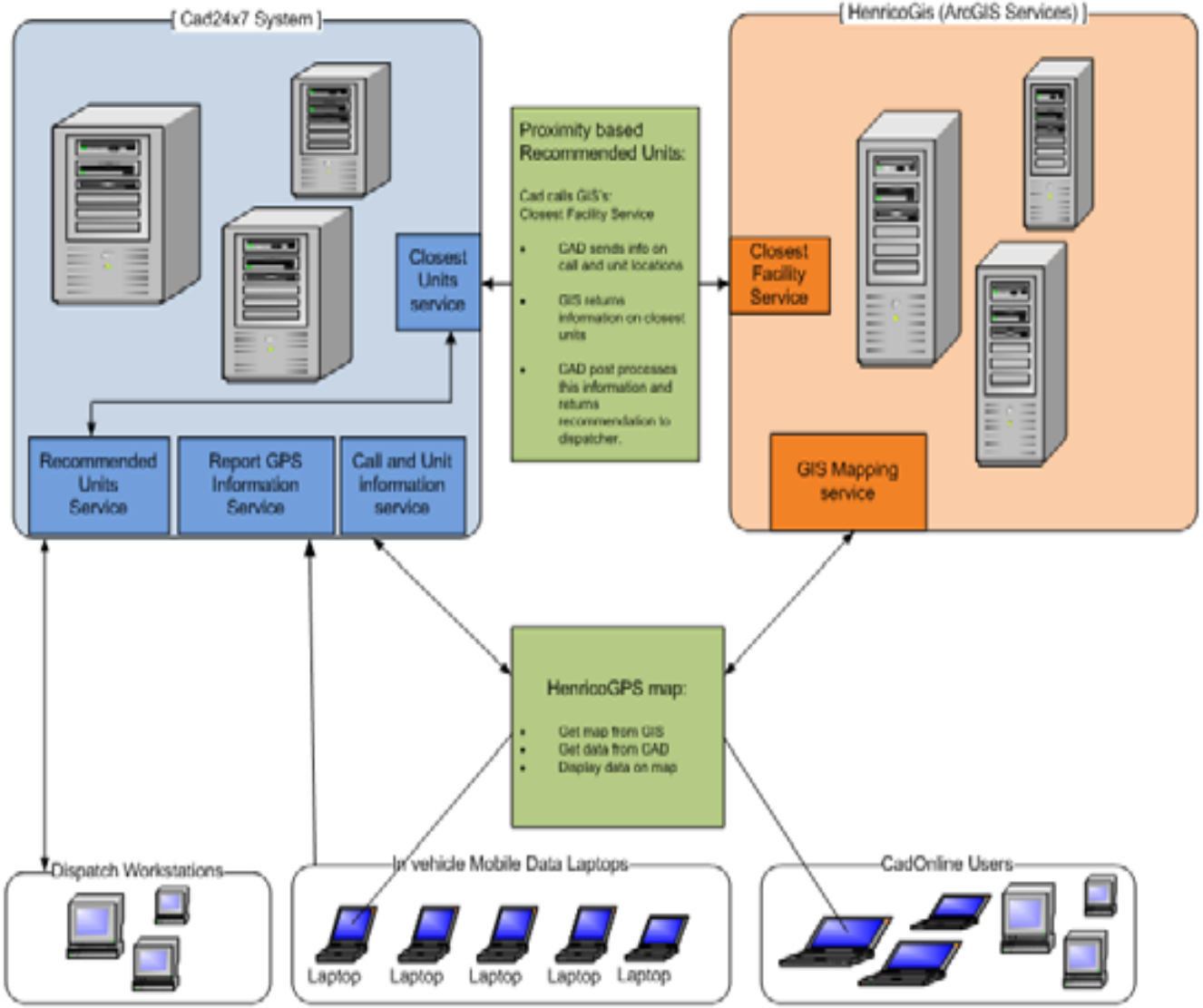
Cad24x7's AVL capability

Cad24x7's AVL capability:

1. GPS data from MDC's is reported to the Cad24x7 system every 10 seconds when vehicles are in motion and every 30 seconds when stopped. Currently this amounts to approximately 600,000 GPS readings daily. This data is used to provide GPS mapping and closest unit recommendations.

2. GPS Map. The HenricoGPS map consumes the Henrico street map service from the HenricoGIS server (see other sidebar). This provides a fully functional Silverlight based map. The map also calls the Call and Unit information service provided by the Cad24x7 system and plots this information on the Silverlight map.

3. Proximity based unit recommendations. When the dispatcher requests unit recommendations for a call for service the Cad24x7 system calls the closest facility service on the HenricoGIS server, providing it a list of the call xy and current unit xy's. The GIS returns an order list of the closest units based upon ETA.



ArcGIS Server

ESRI's ArcGIS server system enables our GIS office to expose certain useful GIS capabilities to the enterprise via a service oriented architecture. Therefore, a system which wishes to display a tiled map in a web browser need only call the map server that the HenricoGIS server farm provides. This same methodology allows the GIS server to expose other useful services such as routing, aerial photography, network analysis and geometry services.

These services are authored using standard ESRI desktop tools are are published as services to the ArcGIS Server. Voirla, instant enterprise GIS.

Services may be consumed by certain out-of-the-box programs provided by ESRI (ArcGis explorer, ArcMap, etc) and by custom written applications using a variety of industry standard interfaces, the most popular of which are the SOAP and REST API's.

GPS Data Collection

- MDC - embedded GPS receivers.
  Transport: Verizon Wireless Broadband
- County IT developed software to capture the GPS data and send it into the Cad24x7 system.
- Read GPS every second.
- Updates CAD every 10, 30 seconds (moving/stationary)
- 90 days of historical data maintained online (50 million rows)
- Re-project X,Y's once (at data capture) to State Plane and WebMecator and store all coordinates on the database.

GPS based data captured

- RMC sentence from NEMA specification
- Unit number
- X, Y position
- Speed (knots)
- Heading
- Fire Station
- Zone
- Date time of reading
- IP Address
- Error flag

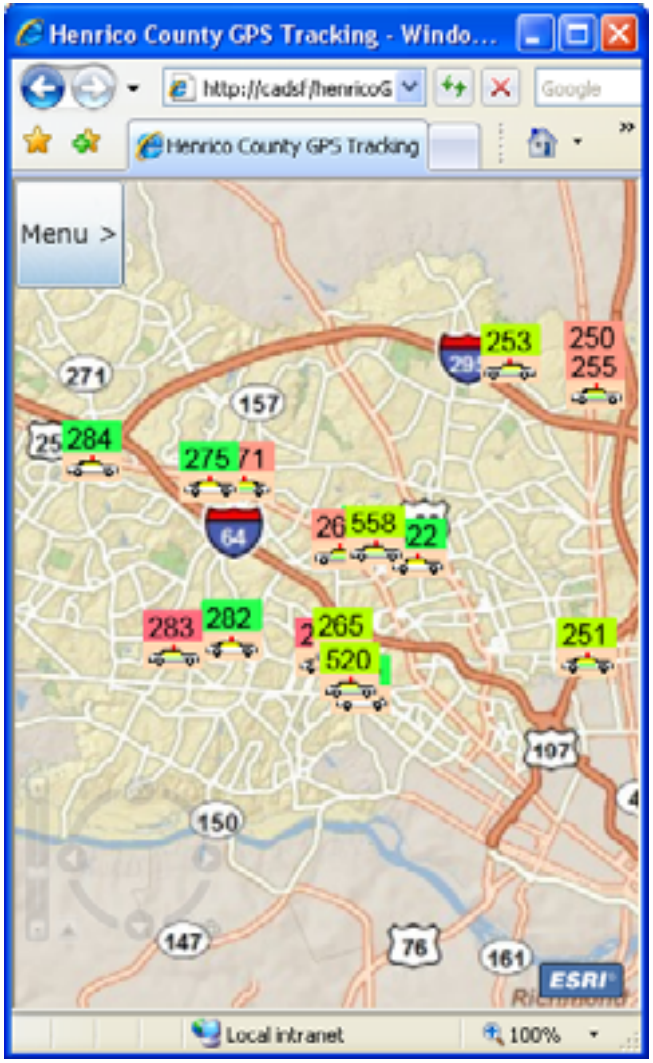
GPS Data Collection: What we learned

- This is the hardest part of the project.
- You have to allow for non-reporting units
- Produces a lot of data (550K rows/day) so data model is essential to good performance. We use two tables:
  - Last good reading (by IP address) 700 rows
  - GPS history (90 days online - 50 million rows)
- Speed = Pandora's box.
- Very helpful to store in the CAD database as you will need to join the GPS data to other CAD data to produce meaningful information. The small table size of the "last good reading" table very helpful here.
- Cache results for performance and scalability

Visualization

- Mapping
- Routing
- Replay
- Links to oblique aerial photography
- There’s an App for that:
  - Visualization - mapping
  - Officer safety – see where the unit is
  - Investigation and analysis – visual replay
  - Routing
    - How do I get there from here.
    - Finding the closest fire hydrant for tanker truck refills.

HenricoGPS Map



- The HenricoGPS map provides a mash-up of call for service and unit information drawn from the Cad24x7 system displayed upon a tiled base map provided by the GIS office.
- Demo

Routing

Demo

- Provides visual route and directions from a unit or address to a desired location.
- Route me to my call for service
- Find the closest fire hydrant
- Dependent on the GIS departments' network analyst server

Replay

Demo

- Displays previous Henrico Public Safety vehicle locations.
- Currently used by Internal Affairs and the crash team
- Replays a unit for a given time period
- Replays all units responding to a call for service

Turning data into information

- GPS data -- provides spatial component

- CAD contains data on unit activities and circumstances

- Together provides information on unit activities and whereabouts and provides basis for applications to:

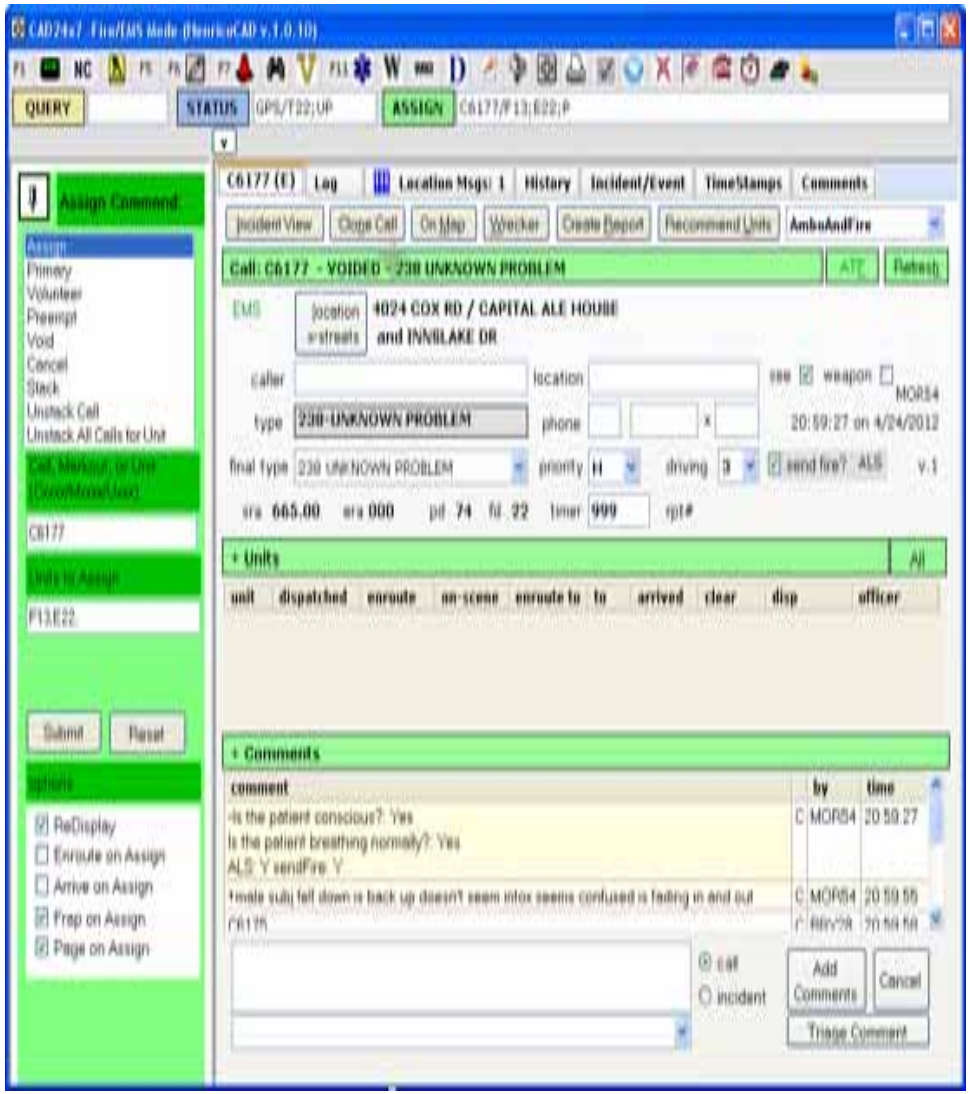
- Improve citizen safety thru quicker response
- Enhance officer safety by showing current locations
- Improve efficiency of resource utilization
- Improve management information

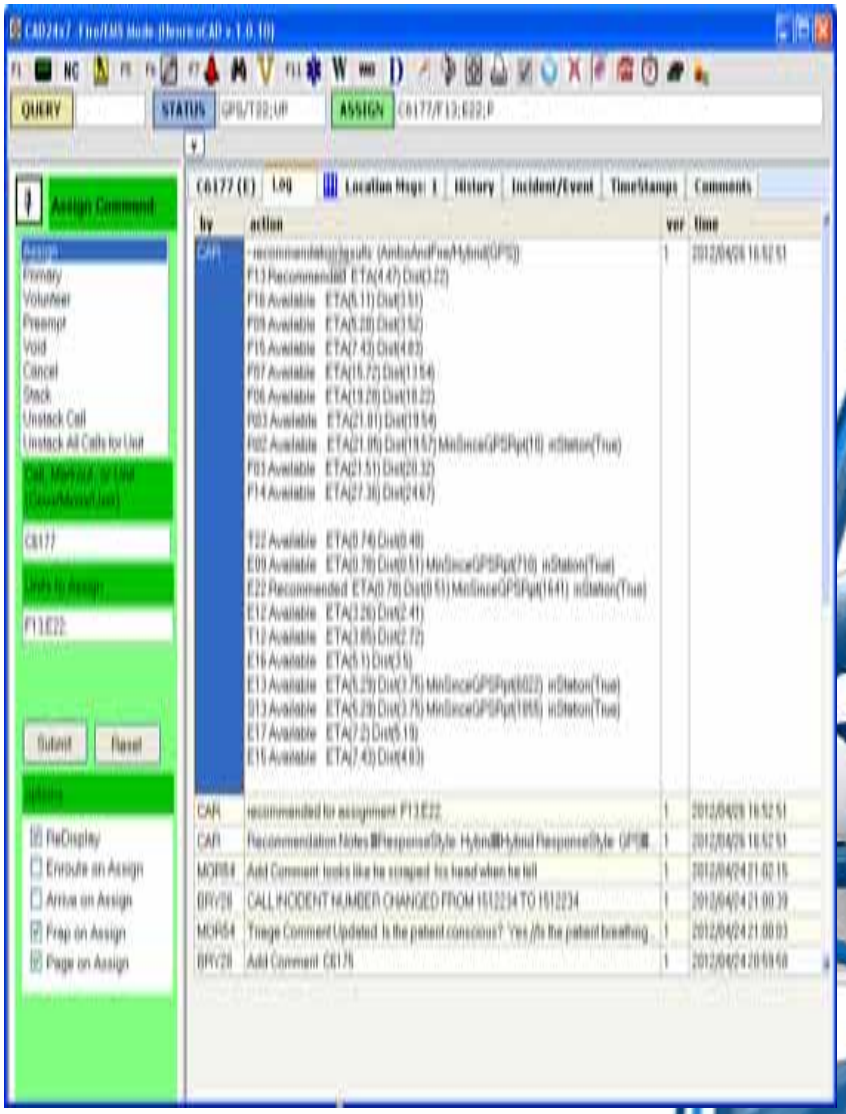
Recommended Units

- Server to Server: Cad24x7 to HenricoGIS.
- Enables post-processing of spatial data;
- Also need to apply business rules.
- SOAP API call to NAServer.ClosestFacility
- Facilities: Unit location collection
- Incident: Call for service location
- Objective: an ordered list of units by ETA.
- Returns only data.
- Average response time < 3 seconds.
- Timeout set to 5 seconds
- Have a static recommendation capability for backup.

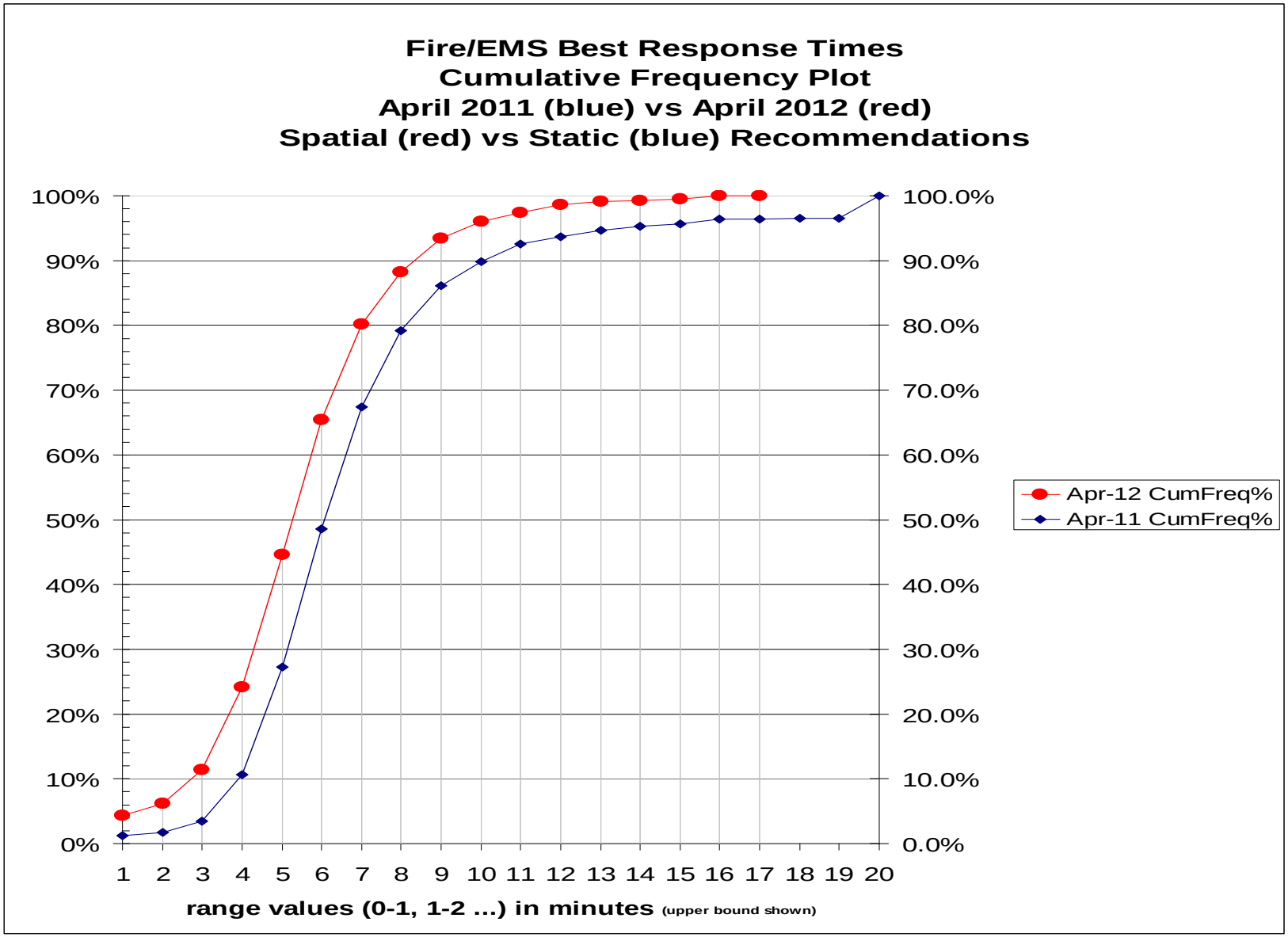
GPS Based Unit Recommendations

[Demo]





Results: How spatial recommendations affected response times.



Where do we go from here

- In vehicle navigation
- Continued evolution of map (Demo Pictometry)
- Shared markup
- Interface with mobile data application (replace old existing “MO” map with an ArcGis Runtime map)
- Data mining for predictive response. Modeling call arrival locations and times to all for posting units at locations where it is more likely to be nearer to a call.

Conclusion: How ArcGis Server Enabled us to create our own ALV system

- Enumerate tasks needed to create an AVL system:
  - **Read GPS** (read from serial port)
  - **Send data** to service (web service call)
  - **Store in database**
  - **Read from database** and display on **tiled map**.
  - **Recommend available units to respond** based upon **who's closest**.
  - Provide units information on the **best route** to take to a call.
- We could do all of **these** tasks by ourselves.
- We could not do **these tasks** without ArcGis Server.
- By making the impossible tasks possible ArcGis Server has put this project within our reach.

Questions:

Credits

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