Applications of Advanced Network Infrastructure in Health and Disaster Management

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Acknowledgement: Project Team

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  - **Thomas E. Terndrup**, MD, Professor and Chair, Department of Emergency Medical Services, School of Medicine, UAB (left UAB in Nov 2006)
- **Project Manager**
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Overview of Presentation

- **Objectives and Scope**
- **Technology Assumptions (in 2002)**
- **Enhance Network Infrastructure for Emergency Medical Services**
  - Next Generation Emergency Medical Dispatching
  - Next Generation Emergency Medical Responder
  - Wireless Communication Test Bed
- **Summary of Progress & Lessons Learned**

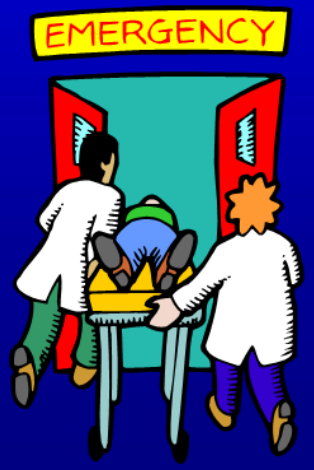
Traditional EMS Patient Flow

9-1-1 Dispatcher

Ambulance dispatched

EMT stabilizes Patient

Hospital ED



Patient Triage & Transport

Treatment

Specific Objectives (1 of 4)

- **Enhance Emergency Medical Dispatch**
  - GIS/GPS enhanced maps for dispatching
    - Display static and dynamic EMS resources
    - Display maps in EDs and BREMSS
  - Enhance quality of medical dispatch
    - Criteria-based Dispatching
    - Use information from regional Emergency Medical Patient (EMP) Database (requires patient ID)
  - Push dispatch data to Fire Station
    - Enhanced “Rip & Run” process
  - Push patient data to ambulance server or EMS Provider’s electronic Patient Care Report (ePCR) terminal

Specific Objectives (2 of 4)

- **Enhance EMS Provider Capability**
  - Use GPS-enhanced maps on ambulances & transmit GPS coordinates to dispatch
  - Link ambulance to BREMSS' LifeTrac System
    - BREMSS provides up-to-the-minute information on available hospital resources for acute trauma, cardiac, stroke events (avoids diversions)
  - Use wireless tablets as electronic Patient Care Report (ePCR) terminals
  - Use Wi-Fi hotspot around the ambulance to link ePCR terminals with ambulance network
  - Use public Wi-Fi, Wi-Max, or 3G (EV-DO) for wireless WAN communication with central database

Technology Assumptions (1 of 2)

- **Enhanced IP-based Infrastructure**
  - **Cellular WANs (3G & 4G)**
    - 3G will be available
    - GSM (UTMS) and CDMA are merged
  - **Wi-Fi (802.11a, b, g, n)**
    - Many public hotspots available to EMS
  - **Wi-Max (802.16)**
    - Will support mobile wireless
  - **Mobile Broadband Wireless Access**
    - IEEE 802.20
- **Smart Antennae**
  - **Able to focus and beam toward EMS providers to extend reach**

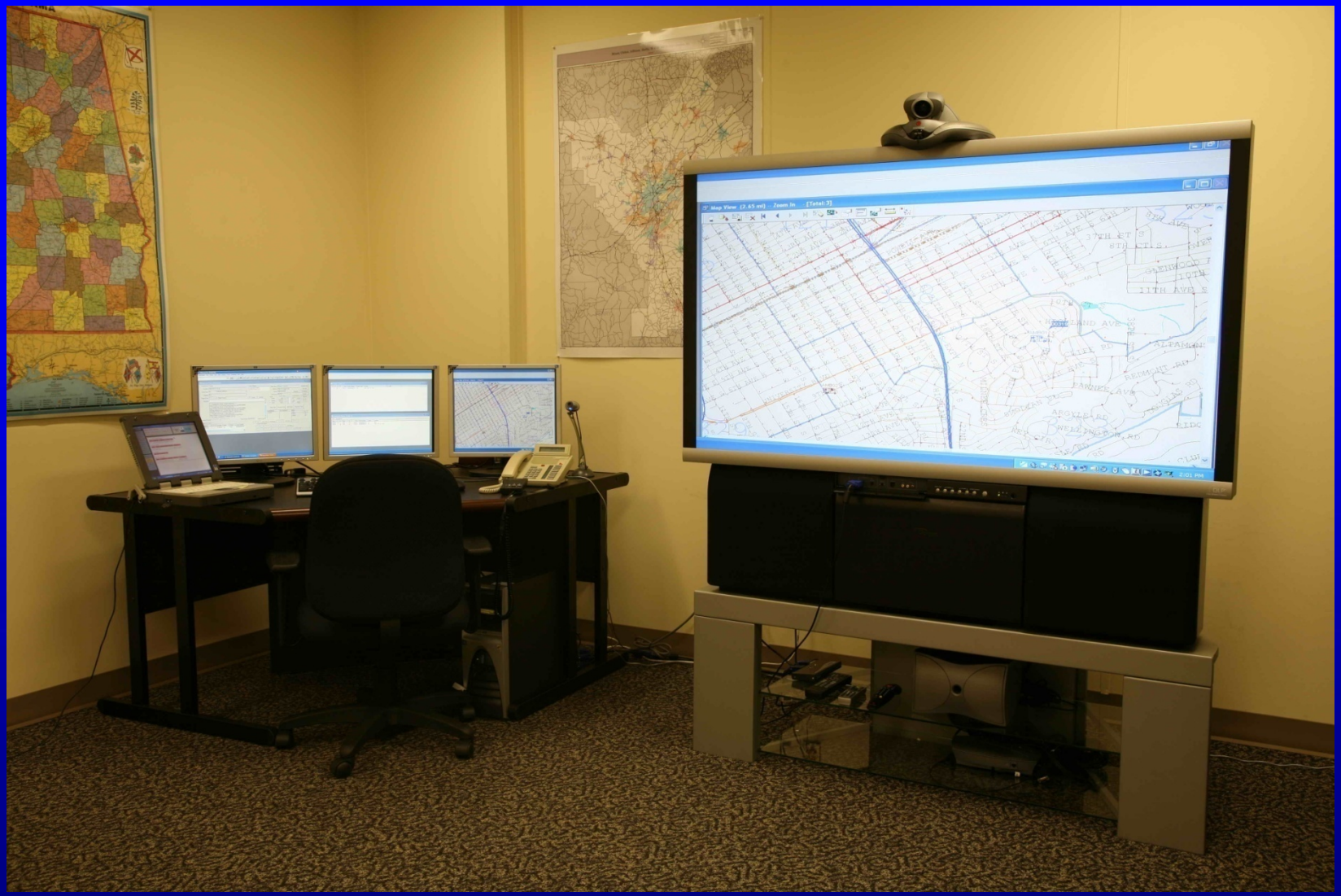
Technology Assumptions (2 of 2)

- Wireless Hand-held Devices
  - Cell Phone, PDAs, Tablet PCs
  - Wearable Computers
  - Clinical devices capturing vital signs
- Regional Emergency Medical Patient (EMP) Database
  - Patients can be identified reliably
  - Patient data is safe and secure
- Clinical Expert Systems for EMS
  - Computer-based EMS protocols
  - Clinical advice and reminders are available in the field

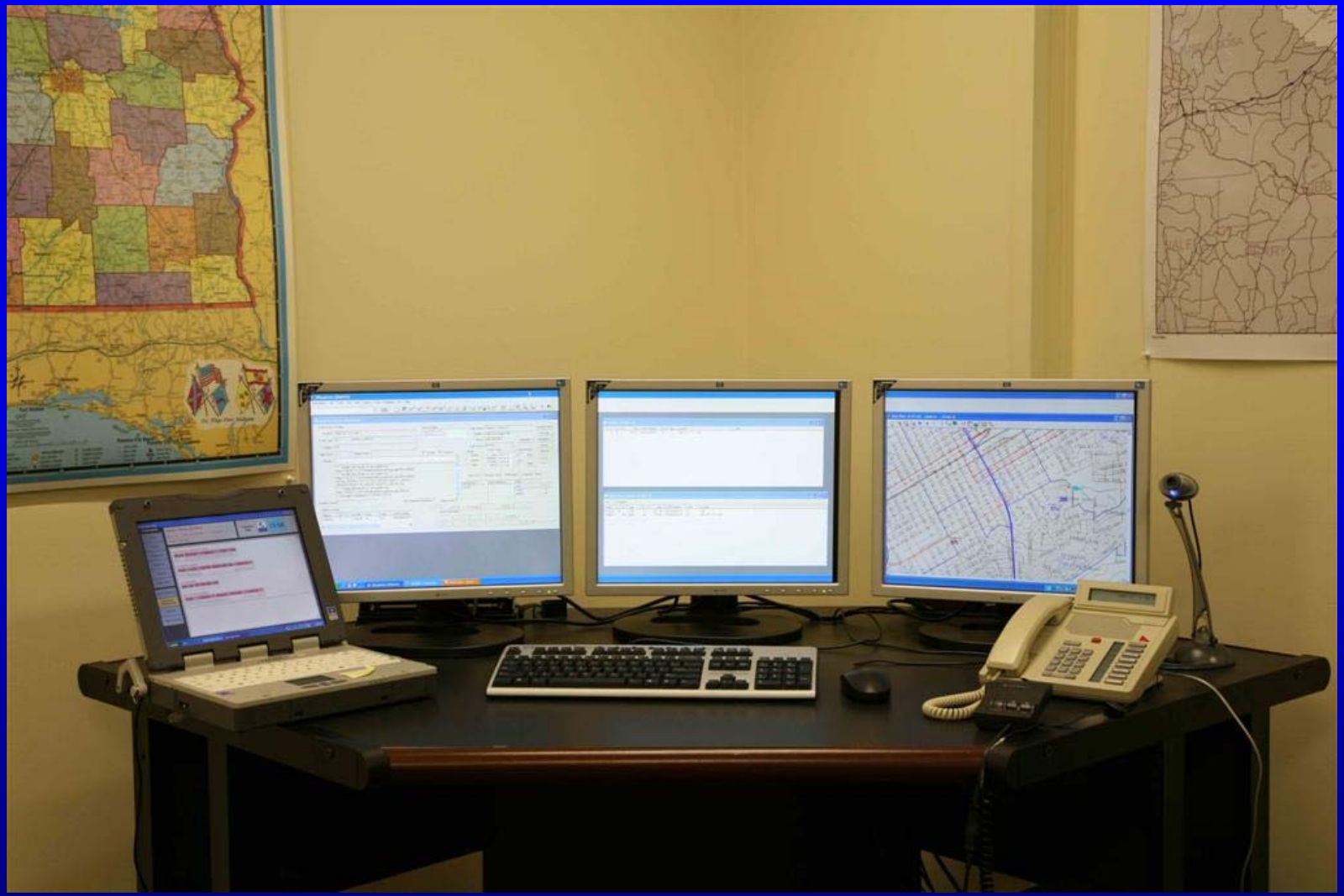
Emergency Medical Dispatching

- **Computer Aided Dispatching (CAD)**
  - We use Intergraph's CAD System
- **Emergency Medical Dispatching (EMD)**
  - Started in the 1970s by Dr. Jeff Clawson in SLC, UT
  - Professionals with minimal training
  - Determines level of EMS needed
  - Dispatches appropriate EMS Team
  - Provides pre-arrival support to patient or bystander

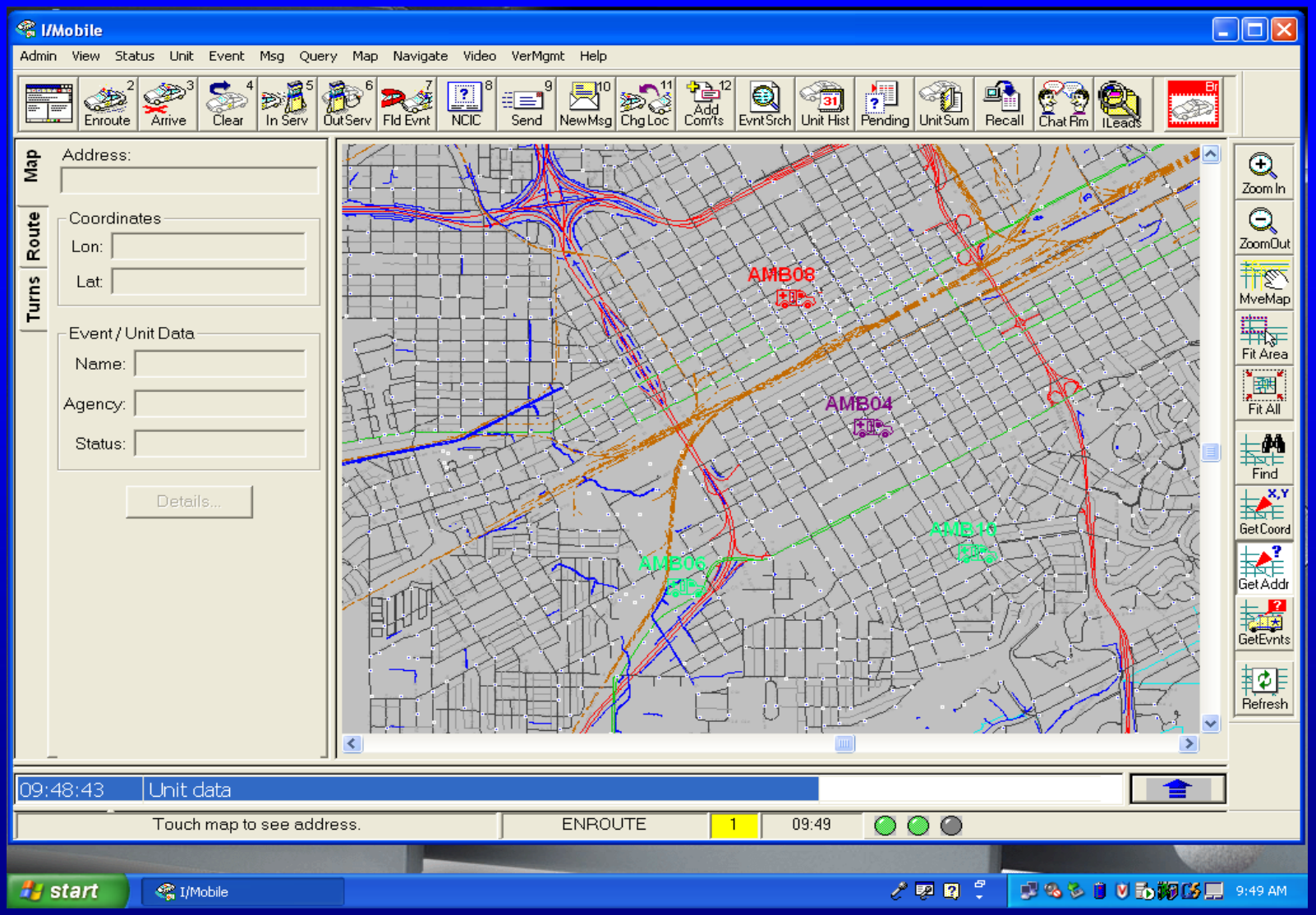
UAB Test Bed in the LRC



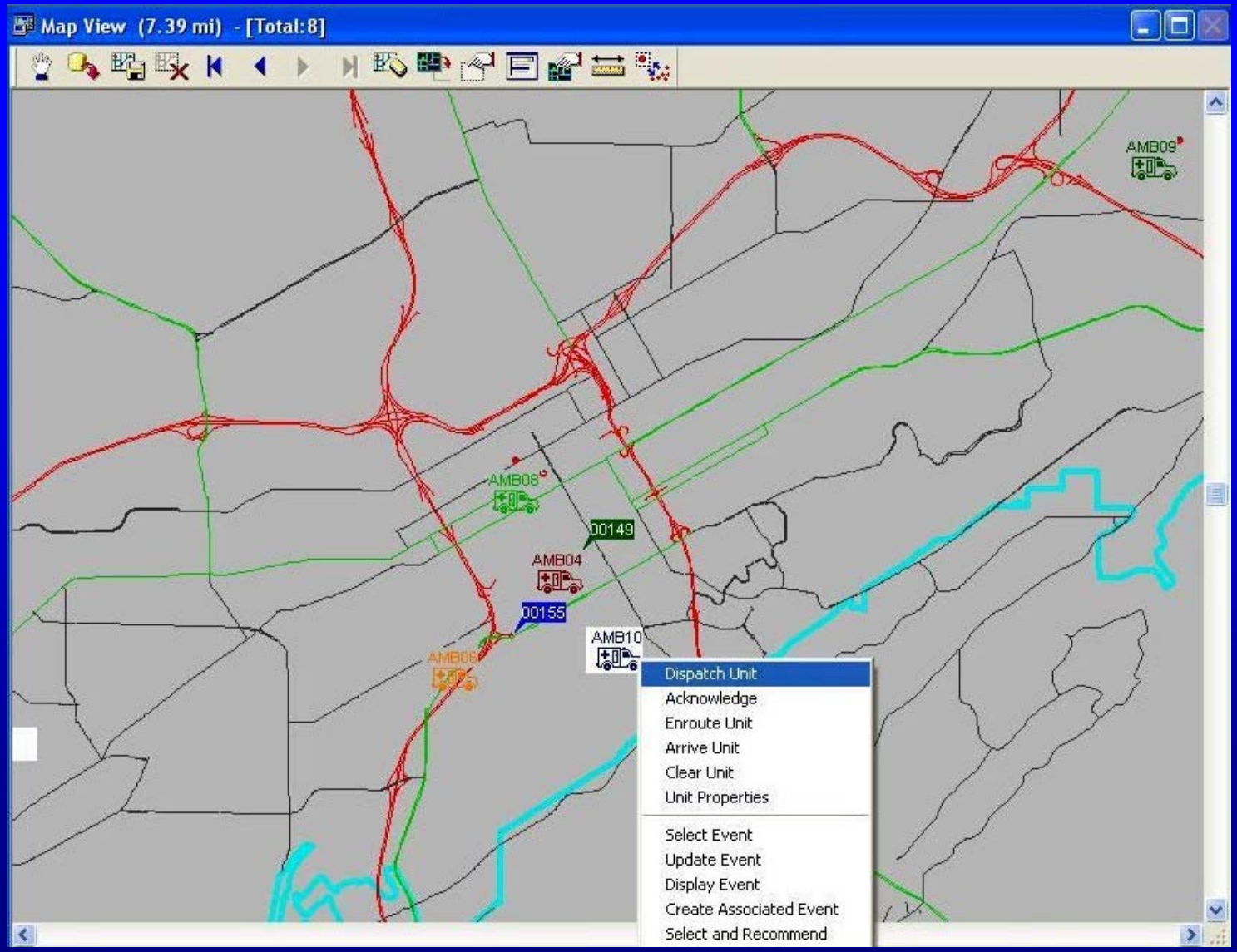
Dispatching Workstation



Intergraph's CAD Map



Street Maps with GPS/GIS



Enhancements to Intergraph's CAD

- **Link to a Regional Patient Database**
  - Very useful if patient can be identified
  - Only limited, potentially life-saving, information need to be available
- **Improved EMD algorithms**
  - Chest Pain (Dr. Ninad Mishra)
  - Trauma Injury (Dr. Muzna Mirza)
- **Map Improvements**
  - Dynamic tracking of ambulance location using GPS coordinates
  - Available at UAB ED and BREMSS via I/Net Viewer
  - Ambulance Status transmitted via MDT

Dispatching: Lessons Learned

- **9-1-1 Call Centers need to improve**
  - Fail-Safe and Scalable (in disasters)
  - Automatic Location Information (ALI) for Cell Phones must improve and VoIP must be supported
  - Regional maps dynamically depicting assets should be available to authorized organizations (e.g., Emergency Command Centers, Emergency Departments, etc.)

Dispatching: Lessons Learned

- **Enhanced EMD Systems**
  - Should have access to patient information for those patients that are at high risk (e.g., “golden hour” events)
  - EMDs should be able to push event data to the MDT of EMS providers
  - EMDs should be able to push patient data to the mobile data terminals of EMS providers (improved “rip & run”)
  - EMDs should be able to receive status information from ambulances or mobile data terminals of EMS providers

EMS Provider

- Most have moderate typing skills and experience with computers
- Concerned about extra work
  - "Paper + Computer = Slower Work"
- EMS (paper) documentation is a problem
  - Over 60% of required data elements are missing (Mandar Gori's thesis)
- Adherence to clinical protocols appears low
  - Could be a documentation problem
- Contact with Online Medical Control
  - Contact is avoided even when required (Dr. Devashish Saini's MSHI Thesis)

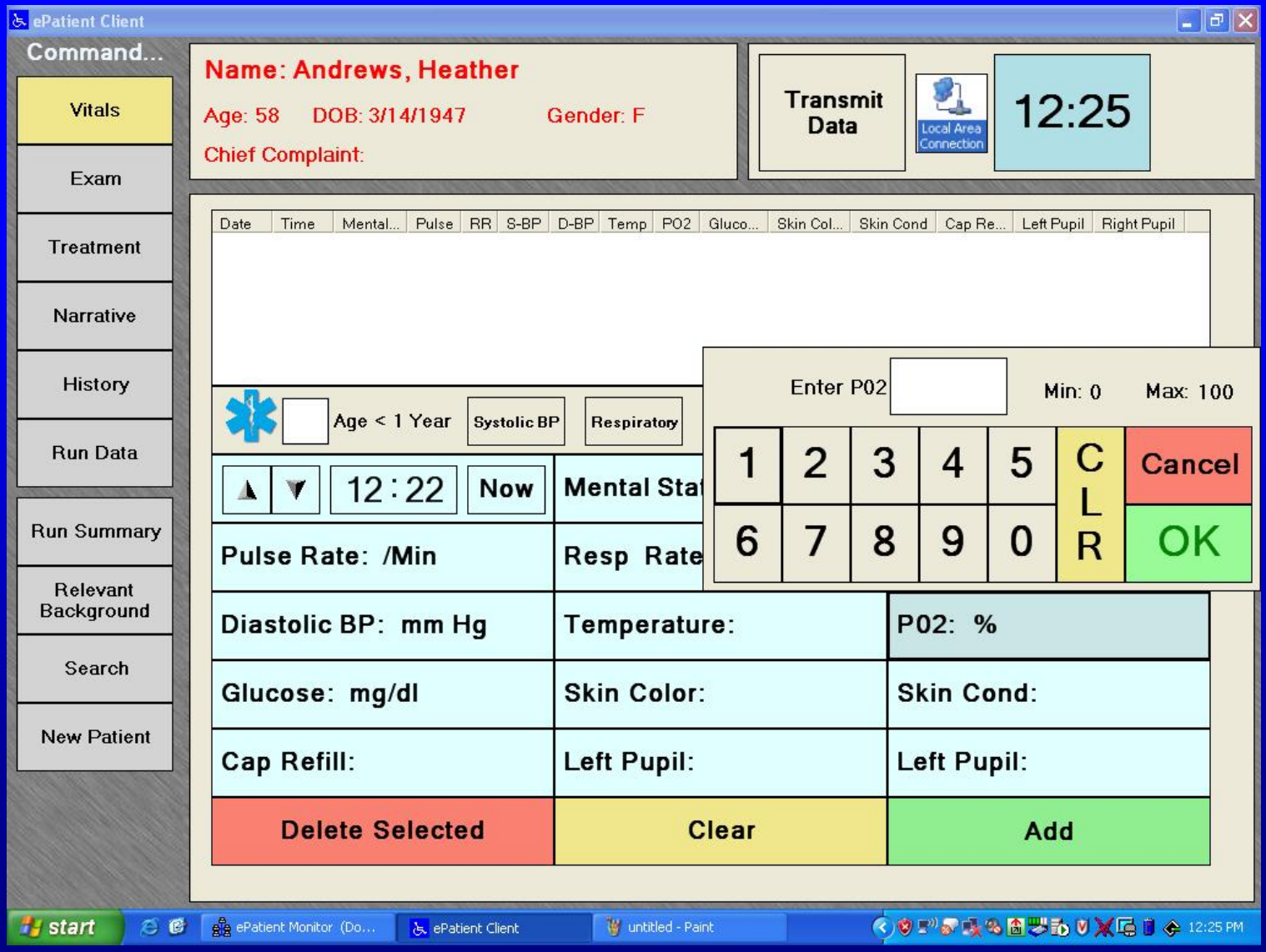
Potential Solutions

- Expert Advice System to evaluate Patient Care Reports (PCRs)
  - Based of AL EMS protocols and EMS Experts
  - Provides feedback to EMTs and/or EMS Quality Assurance manager
  - Feasibility established but not validated (Dr. Devashish Saini's Thesis)

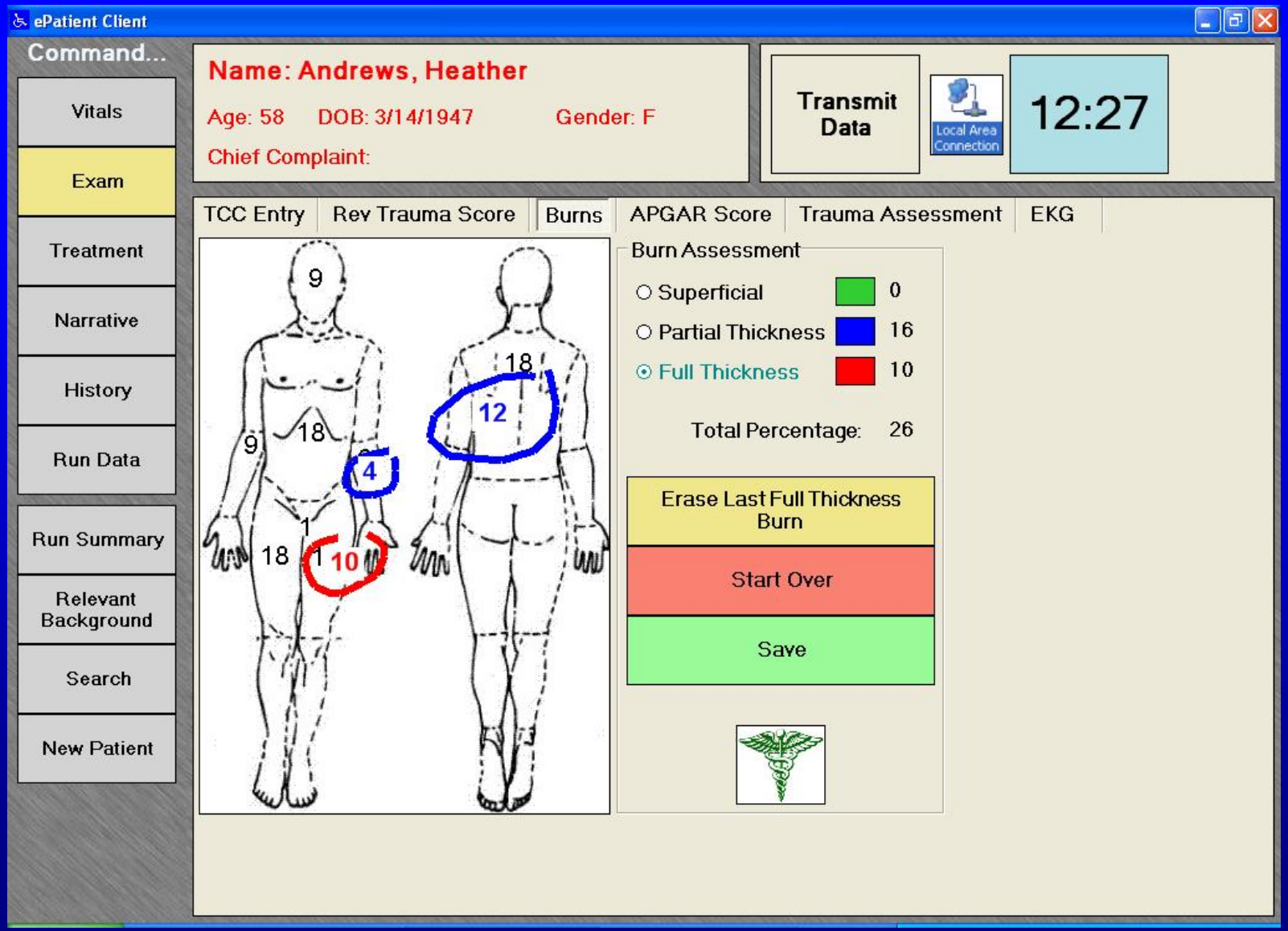
Data Collection in the Field

- Touch Interface
  - Stylus is not usable in ambulance
  - Finger Touch works well but "buttons" must be large
- Voice Command Interface
  - Prototype established
  - Feasibility established but not validated
    - Giovanni Mazza's thesis project

EMS Data Collection: Vitals

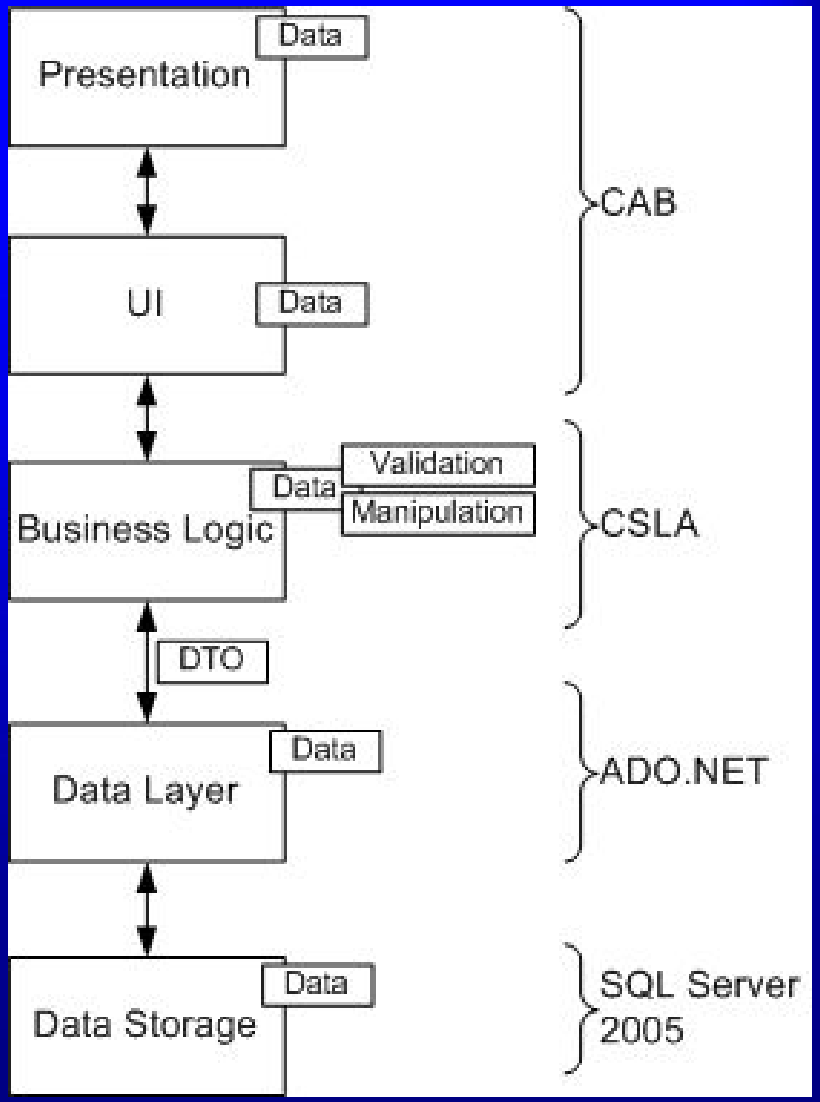


EMS Data Collection: Burns



ePatient Software Architecture

- Layered Architecture
  - Presentation
  - User Interface
  - Business Logic
    - Data Validation:
      - Range Checking
    - Data Manipulation
      - Conversion from common units to international units
  - Data Layer
    - ADO.NET
  - Data Storage



Lessons Learned

- Developing new User Interfaces is very labor intensive
- We use now CAB for the GUI
  - Composite Application Block methodology as advocated by Microsoft's Pattern & Practices Team to develop smart client software
- CAB allows individual GUI modules to be assembled as needed at run-time using XML configuration files
  - The GUI and Business Logic are separated

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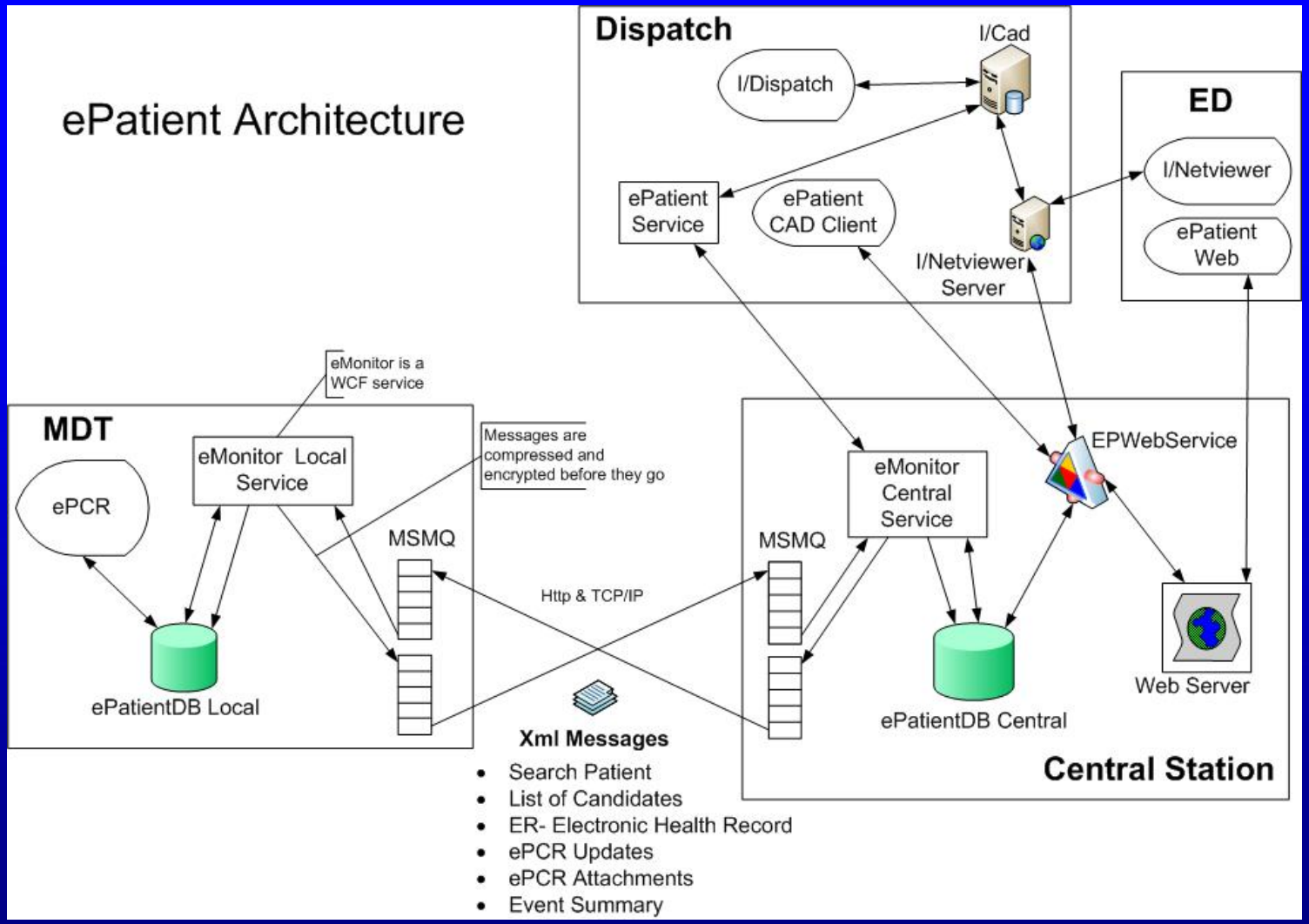
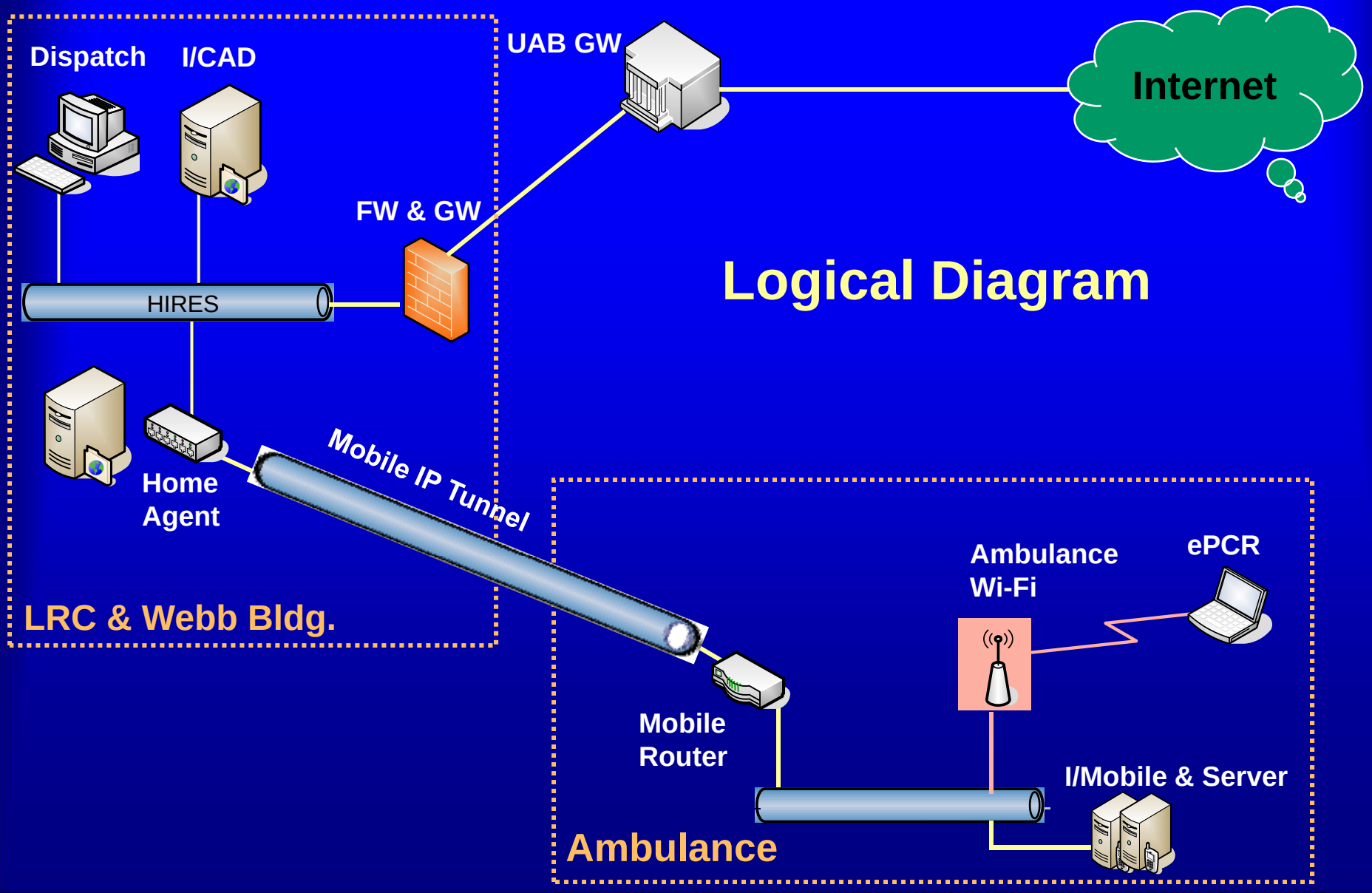
Communication Test Bed

- All communication in the EMS environment needs to be asynchronous
  - An ePCR tablet may be out of range and cannot communicate with the regional or ambulance database
- Each tablet maintains a local version of the main database that is synchronized when connectivity is restored

ePatient Architecture



UAB Communications Test Bed



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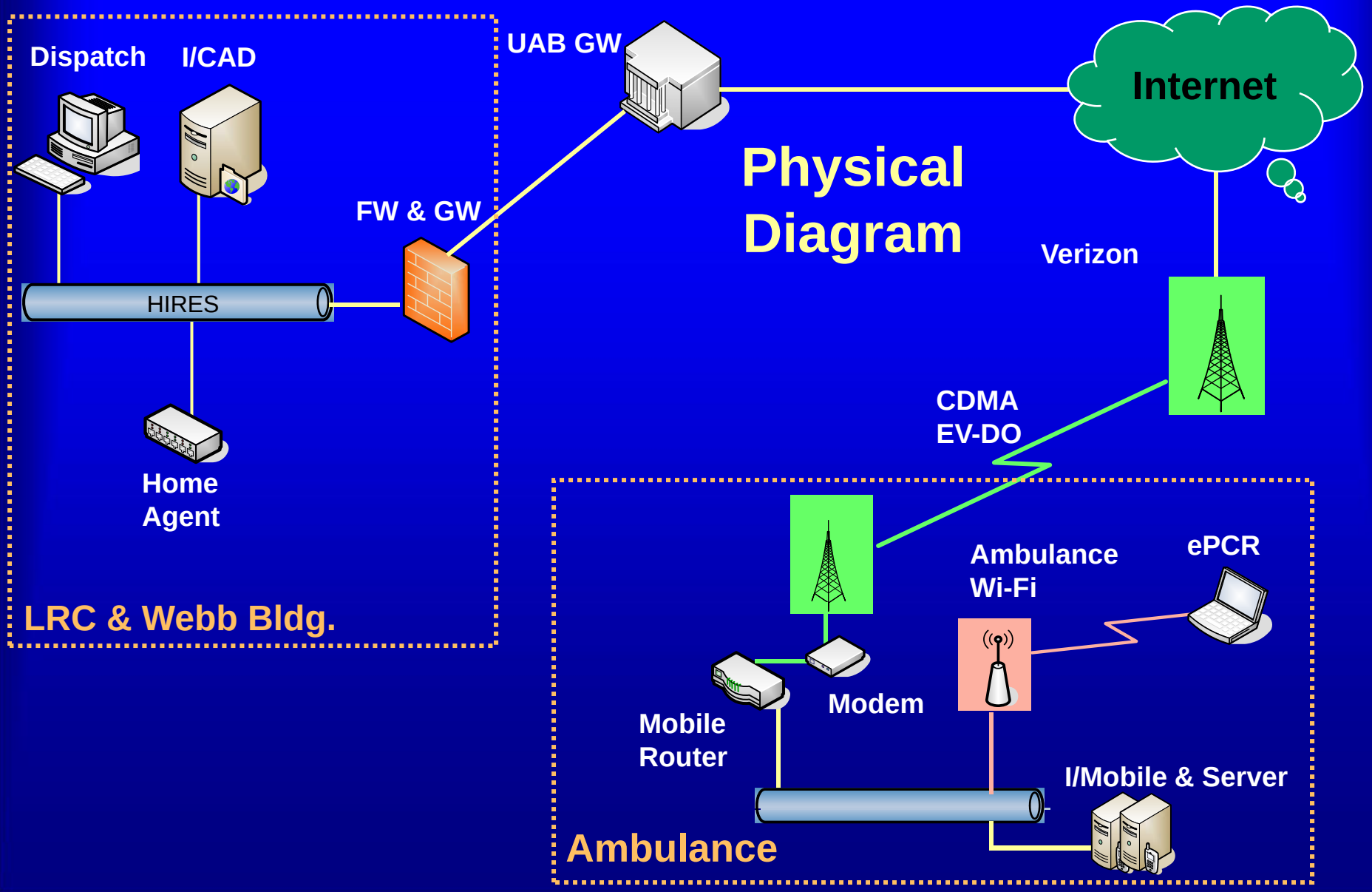

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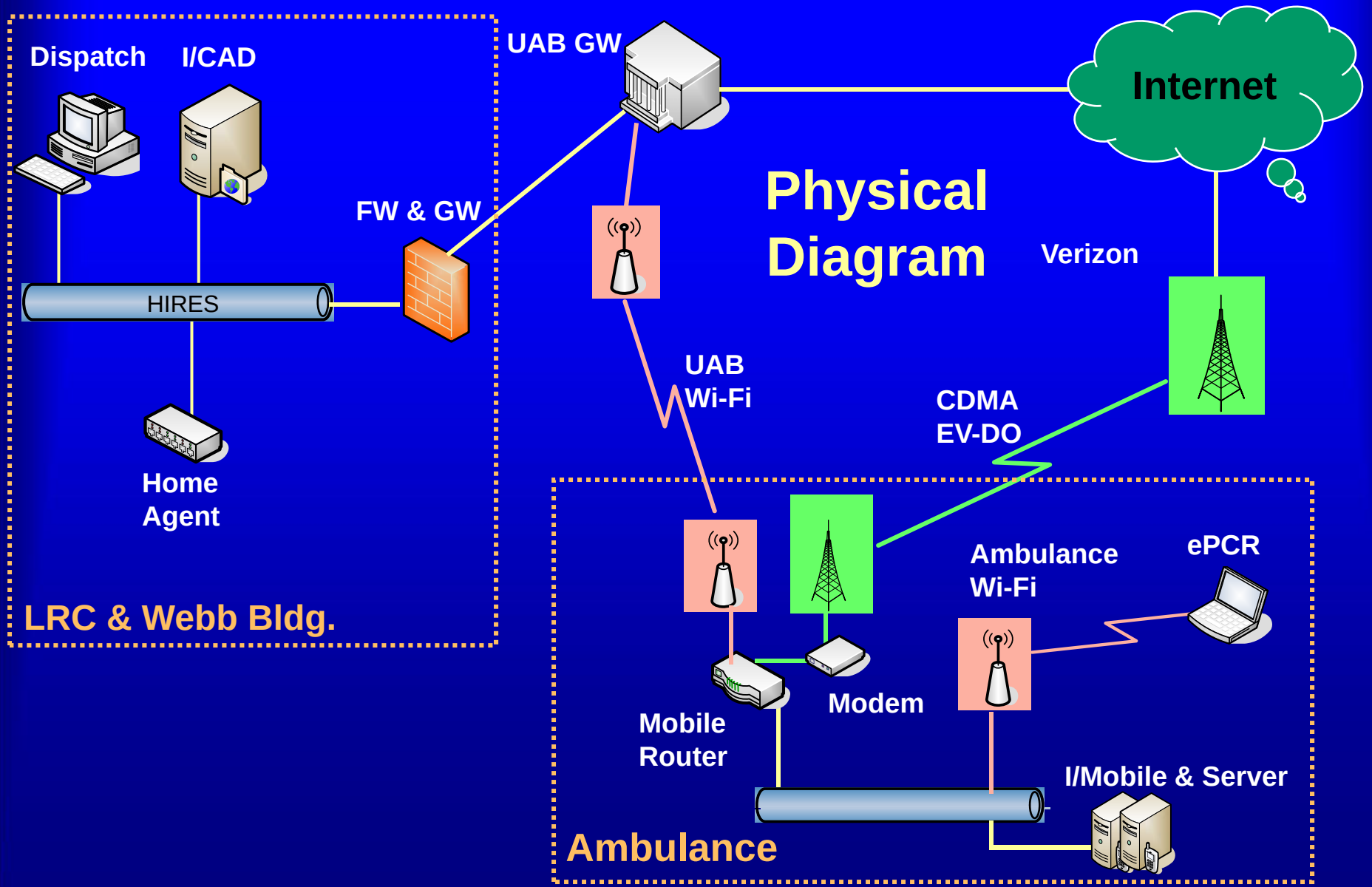
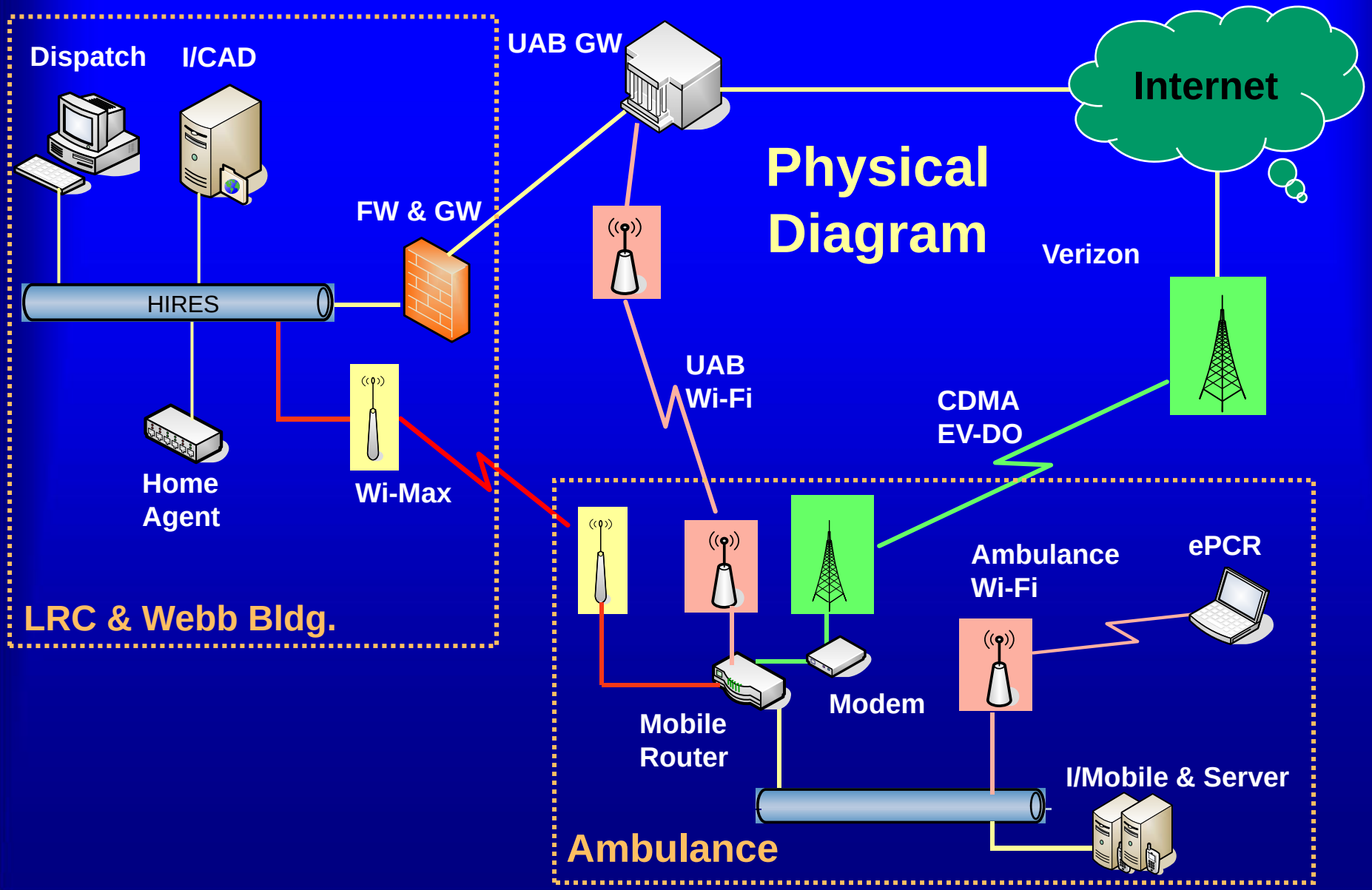
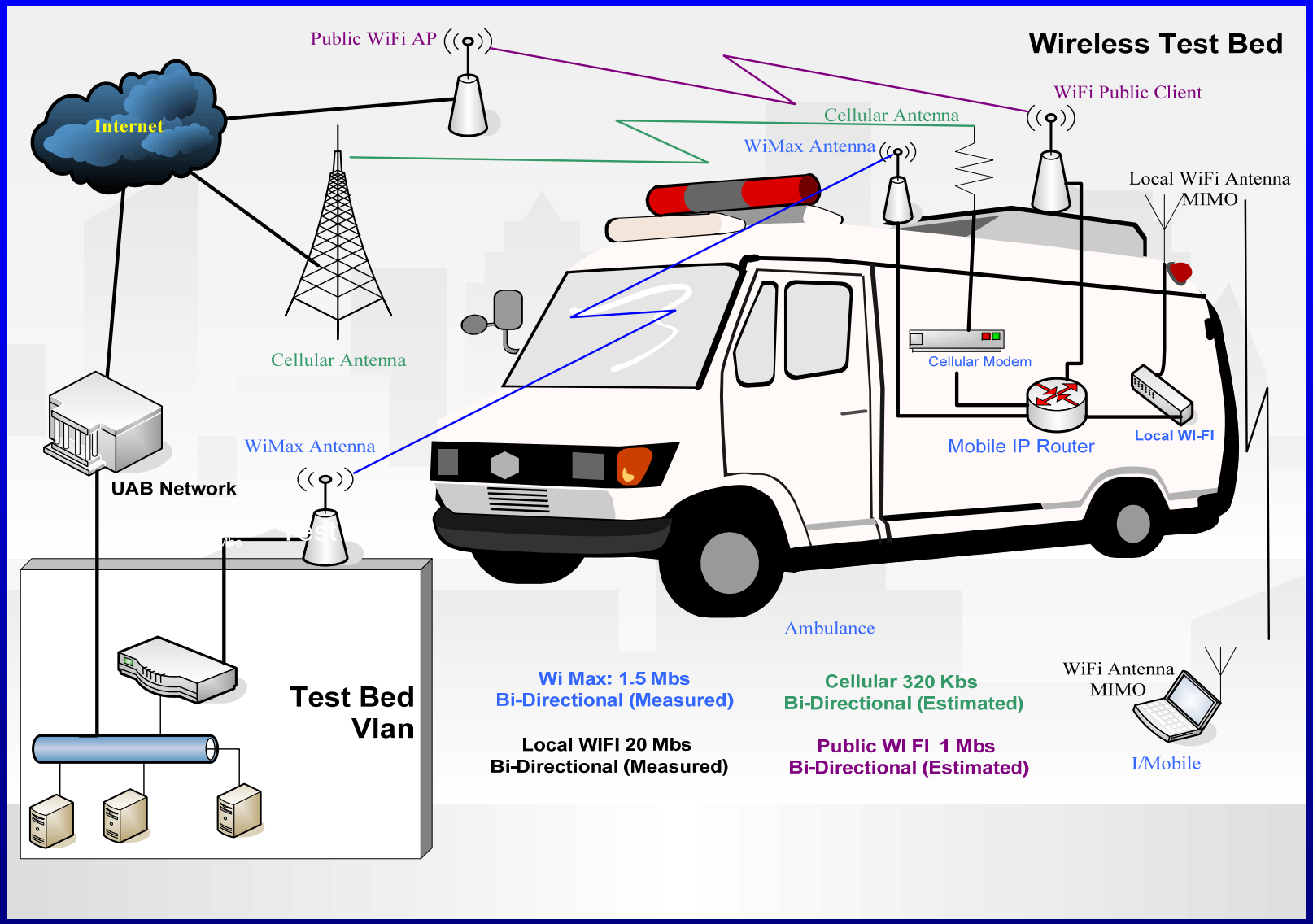


UAB Communications Test Bed



Ambulance Communication



Communication Test Results

- **Wi-Fi Hotspot around ambulances**
  - Tested range with 802.11 a, b, g, pre-n
  - Used “Smart Packets” and “Turbo Codes” to extend communication at the ”fringe” (Manish Mittal’s Thesis)
- **Experiments with Wi-Max**
  - Static Communication – excellent
  - Mobile communication – very poor
- **Experiments with CDMA EV-DO**
  - Works well enough for text data but not for interactive video

Summary: Enhanced Dispatch

- **Completed Test Bed**
  - **Many components**
- **Intergraph I/CAD**
- **Intergraph GIS/GPS System with Map**
  - Street Maps for Birmingham and six counties (BREMSS Region – not complete)
- **Enhanced Criteria-based Dispatch**
  - Chest Pain Cases (Dr. Ninad Mishra's MSHI project)
  - Trauma Cases (Dr. Muzna Mirza's MSHI project)

Summary: Enhanced EMS

- **Wireless Communication Test Bed**
  - Wi-Fi (802.11 a, b, g, n); Wi-Max (802.16); 3G
- **Emergency Medical Patient (EMP) DB**
  - HL7 – CDA compatible; Data Elements follow NHTSA and Alabama guidelines
- **MDT developed with Tablet PCs**
  - Developed GUI for Finger-touch capability
  - Voice enabled ePCR (vePCR - Giovanni Mazza's MSHI project)
  - Developed ePatient Architecture using Web Services and asynchronous http/tcp-ip.

Conclusions

- **The EMS Environment is complex and very competitive**
- **Accurate data capture is poor**
  - EMTs are willing to try but environment is difficult and challenging
  - Have not found the “solution” yet
- **Sharing data is not a reality yet**
  - Most EMS data is ignored by ED