

Applications of Advanced Network Infrastructure in Health and Disaster Management

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Acknowledgement: Project Team

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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



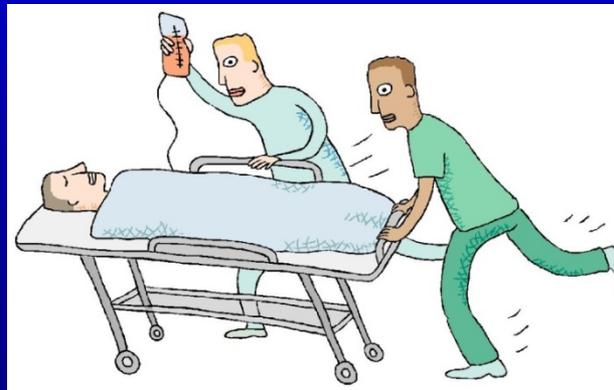
EMT stabilizes Patient



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

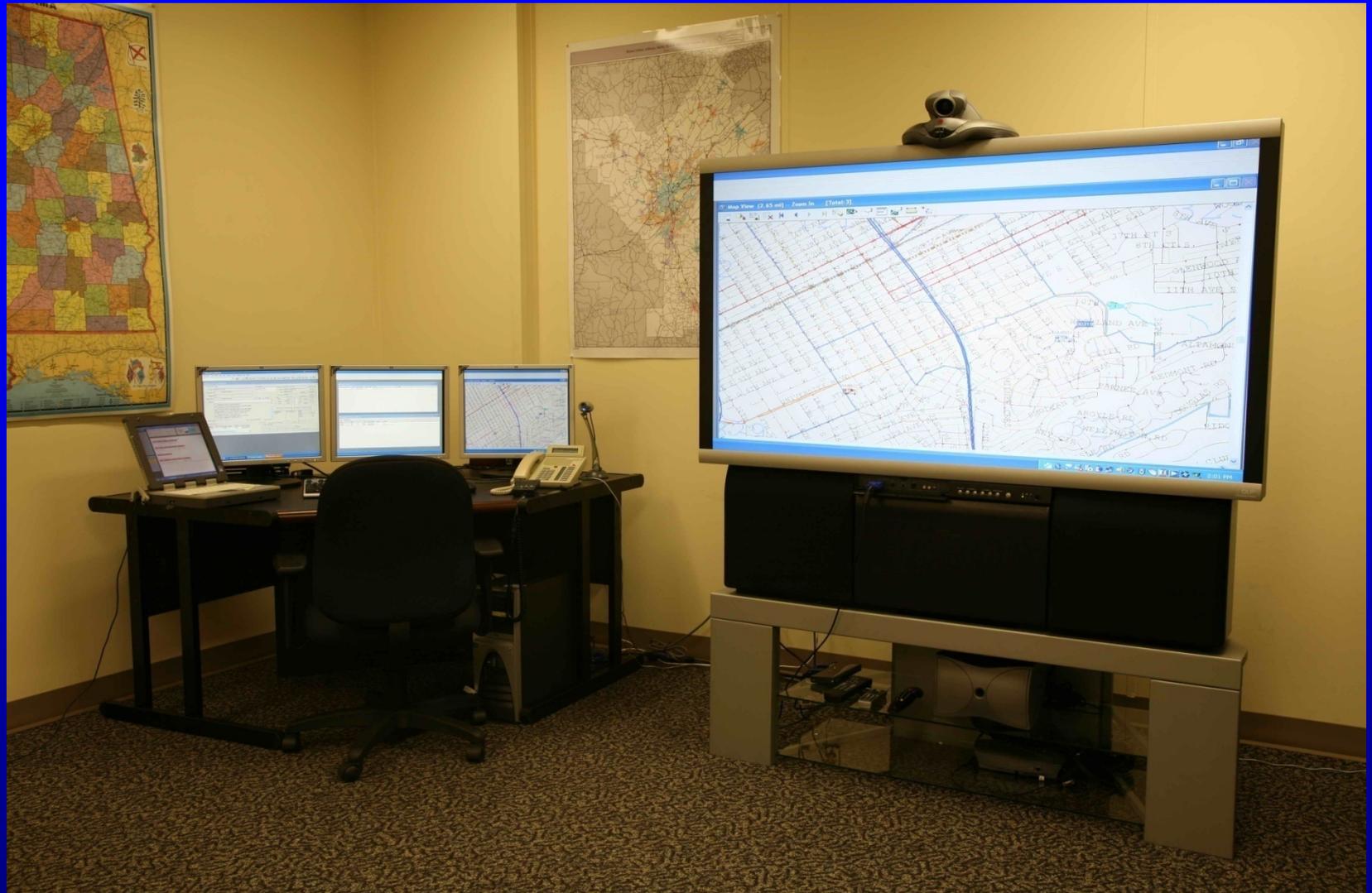
◆ Computer Aided Dispatching (CAD)

- We use Intergraph's CAD System

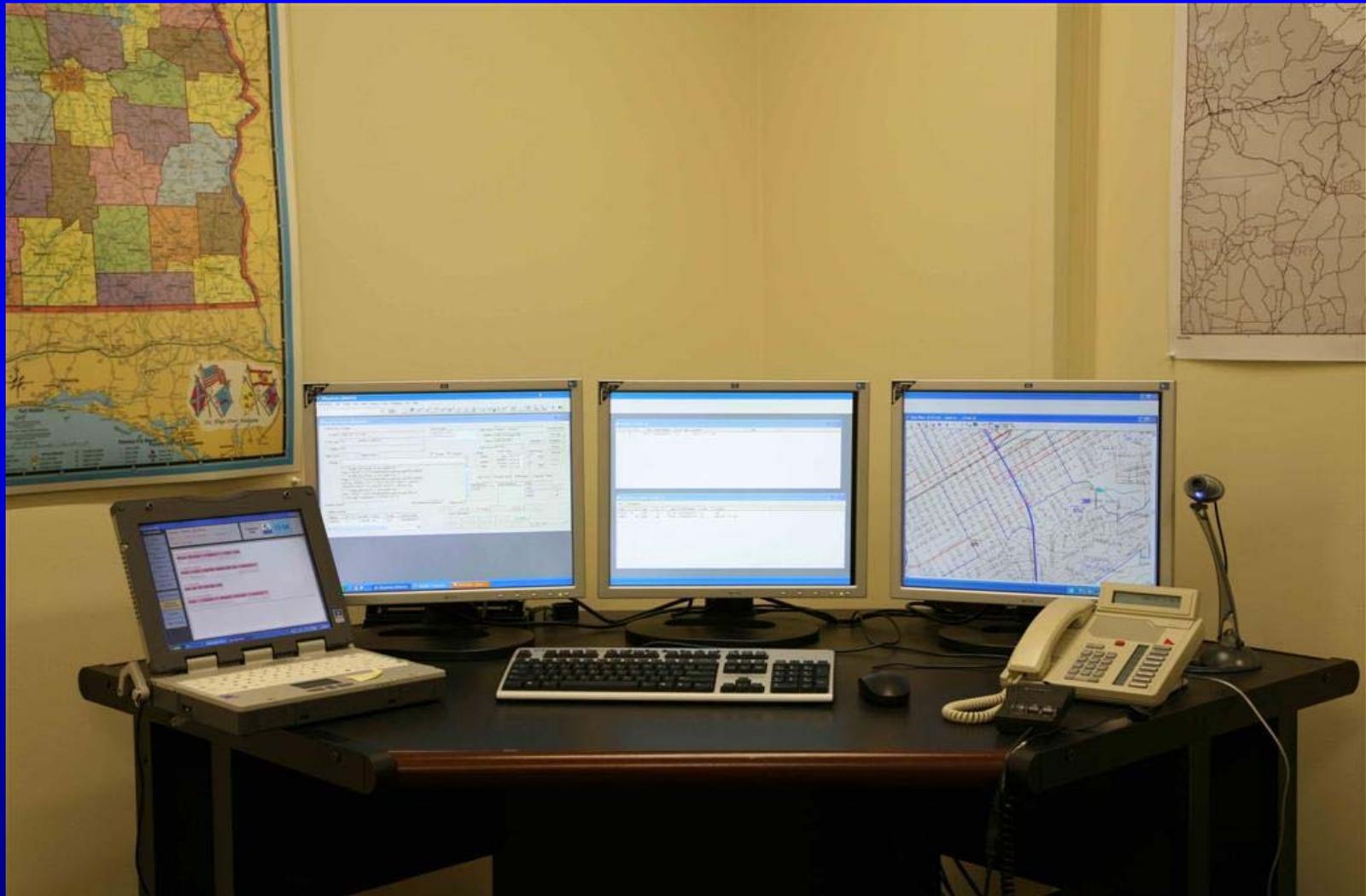
◆ Emergency Medical Dispatching (EMD)

- 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

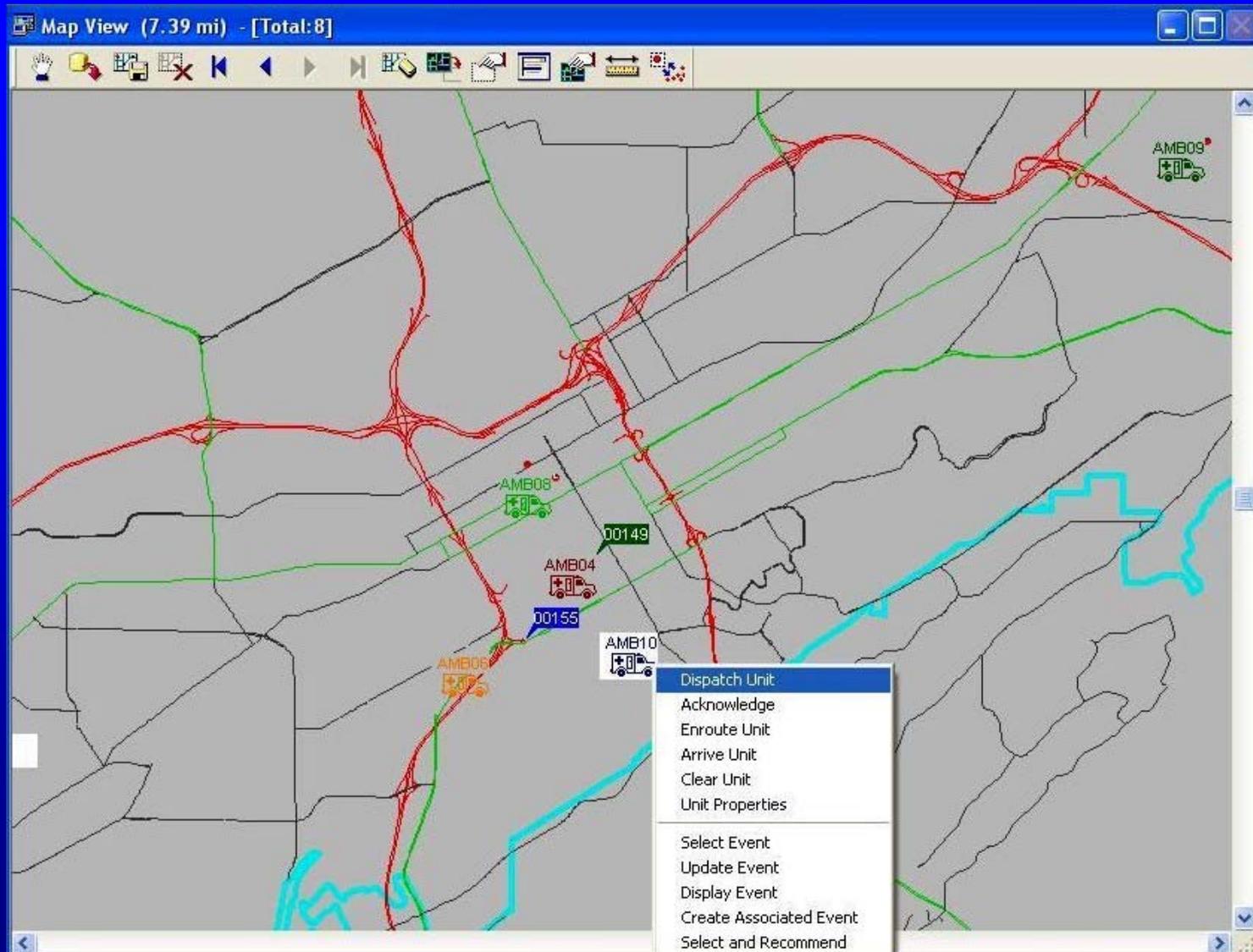
The screenshot displays the Intergraph I/Mobile CAD Map software interface. The window title is "I/Mobile". The menu bar includes: Admin, View, Status, Unit, Event, Msg, Query, Map, Navigate, Video, VerMgmt, Help. The toolbar contains 12 numbered icons: 1. Home, 2. Enroute, 3. Arrive, 4. Clear, 5. In Serv, 6. Out Serv, 7. Fld Evnt, 8. NCIC, 9. Send, 10. NewMsg, 11. Chg Loc, 12. Add Comrts. Other icons include Evt Srch, Unit Hist, Pending, Unit Sum, Recall, Chat Rm, and ILeads.

The main interface is divided into several sections:

- Map:** A central map view showing a street grid with several ambulance units marked: AMB08 (red), AMB04 (purple), AMB13 (green), and AMB06 (green). Colored lines (red, orange, green, blue) represent routes or service areas.
- Left Panel:** Contains input fields for "Address:", "Coordinates", "Lon:", and "Lat:". Below these are "Event / Unit Data" fields for "Name:", "Agency:", and "Status:". A "Details..." button is located at the bottom of this panel.
- Right Panel:** A vertical toolbar with icons for: Zoom In, Zoom Out, MveMap, Fit Area, Fit All, Find, GetCoord, GetAddr, GetEvnts, and Refresh.
- Bottom Status Bar:** Shows the time "09:48:43", "Unit data", a "Touch map to see address." prompt, the status "ENROUTE", a yellow box with the number "1", and the time "09:49".

The Windows taskbar at the bottom shows the "start" button, the "I/Mobile" application icon, and the system tray with the time "9:49 AM".

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

ePatient Client

Command...

Name: Andrews, Heather

Age: 58 DOB: 3/14/1947 Gender: F

Chief Complaint:

Transmit Data  12:25

Date	Time	Mental...	Pulse	RR	S-BP	D-BP	Temp	PO2	Gluco...	Skin Col...	Skin Cond	Cap Re...	Left Pupil	Right Pupil

Enter P02 Min: 0 Max: 100

1	2	3	4	5	C	Cancel
6	7	8	9	0	R	
						OK

Age < 1 Year Systolic BP Respiratory

12:22 Mental Sta

Pulse Rate: /Min Resp Rate

Diastolic BP: mm Hg	Temperature:	P02: %
Glucose: mg/dl	Skin Color:	Skin Cond:
Cap Refill:	Left Pupil:	Left Pupil:
Delete Selected	Clear	Add

start | ePatient Monitor (Do... | ePatient Client | untitled - Paint | 12:25 PM

EMS Data Collection: Burns

ePatient Client

Command...

Name: Andrews, Heather
Age: 58 DOB: 3/14/1947 Gender: F
Chief Complaint:

Transmit Data

Local Area Connection

12:27

TCC Entry Rev Trauma Score Burns APGAR Score Trauma Assessment EKG

Burn Assessment

Superficial 0
 Partial Thickness 16
 Full Thickness 10

Total Percentage: 26

Erase Last Full Thickness Burn

Start Over

Save

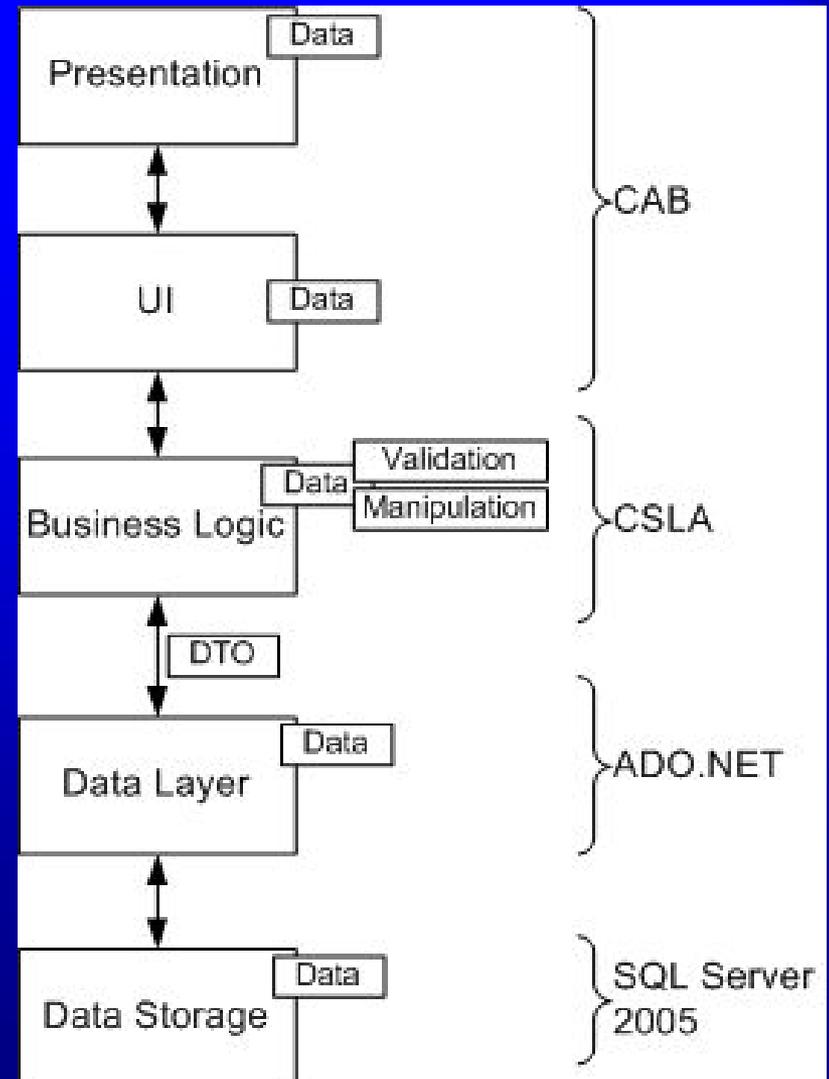


9 18 4 18 12 18 1 10

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

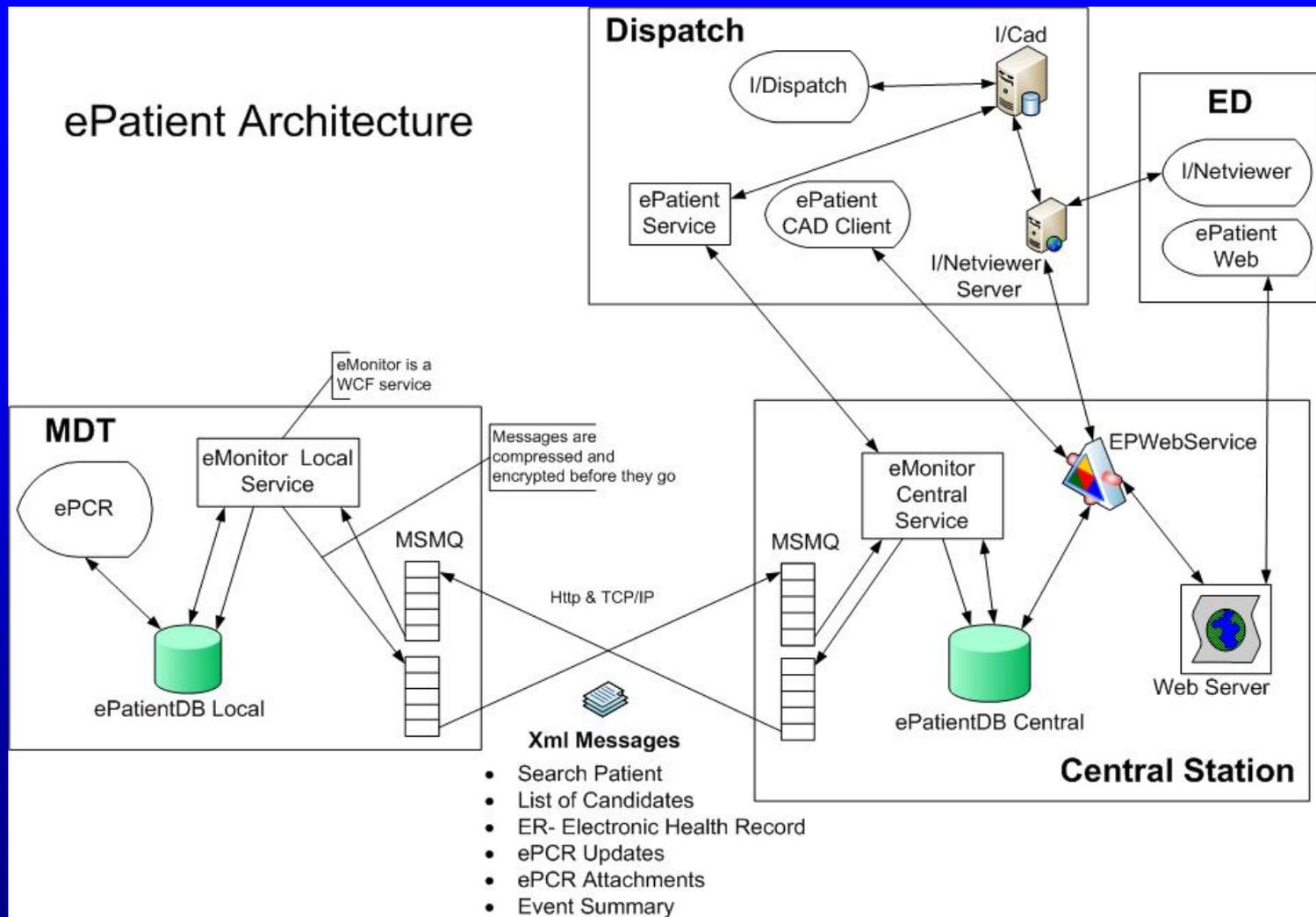
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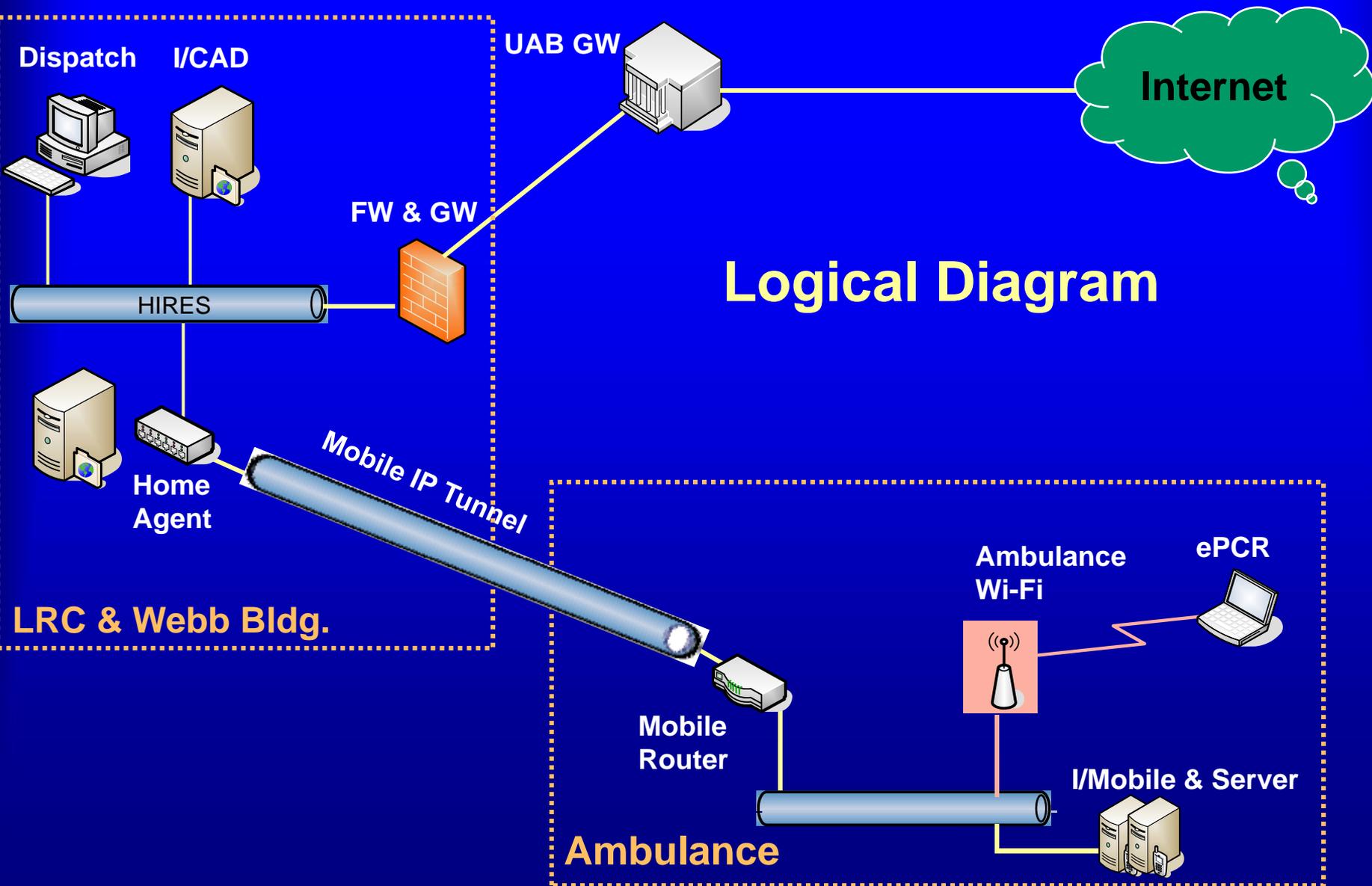
Communication Test Bed

- ◆ 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



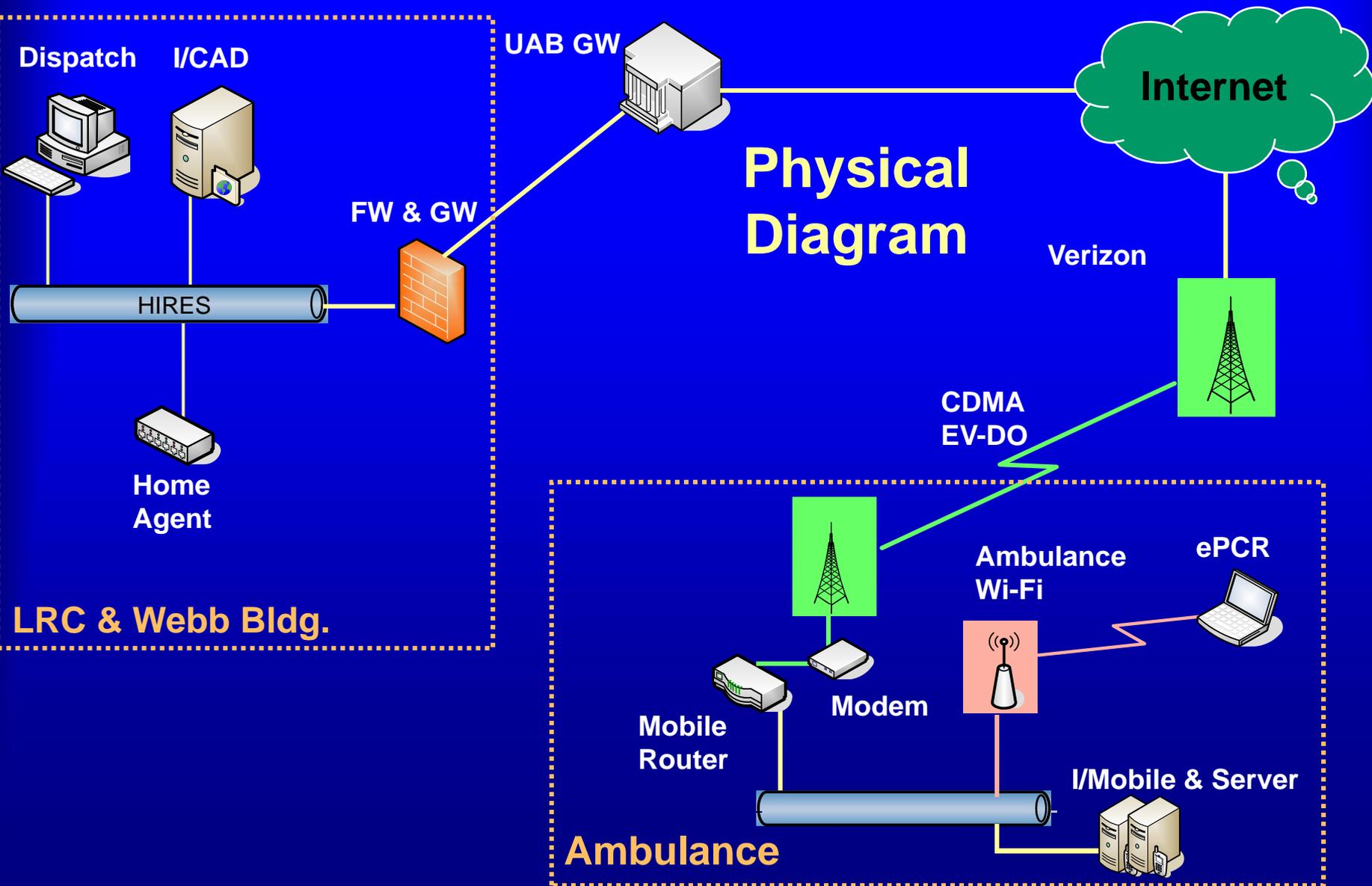
UAB Communications Test Bed



Logical Diagram

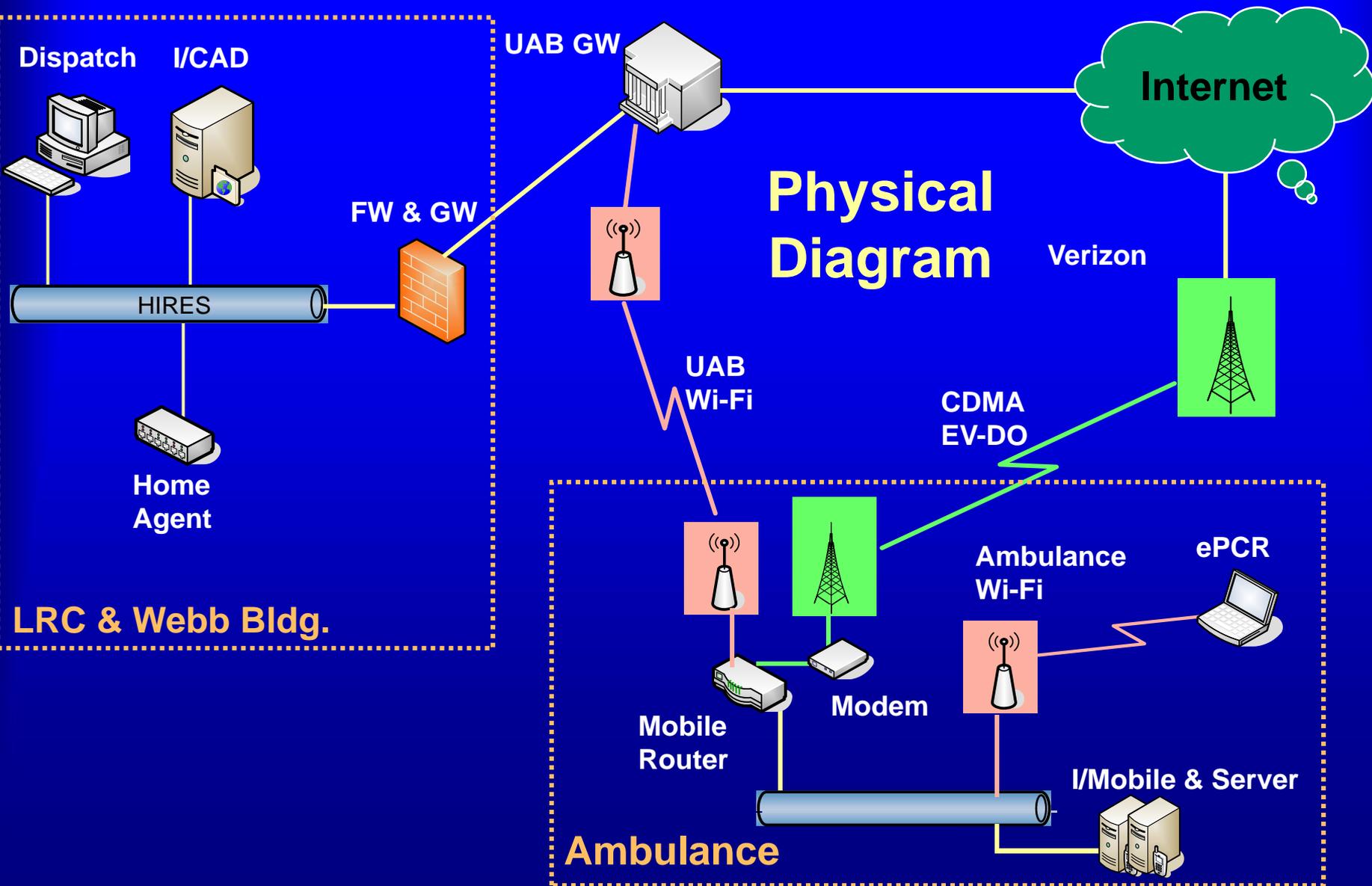
UAB Communications Test Bed

Physical Diagram



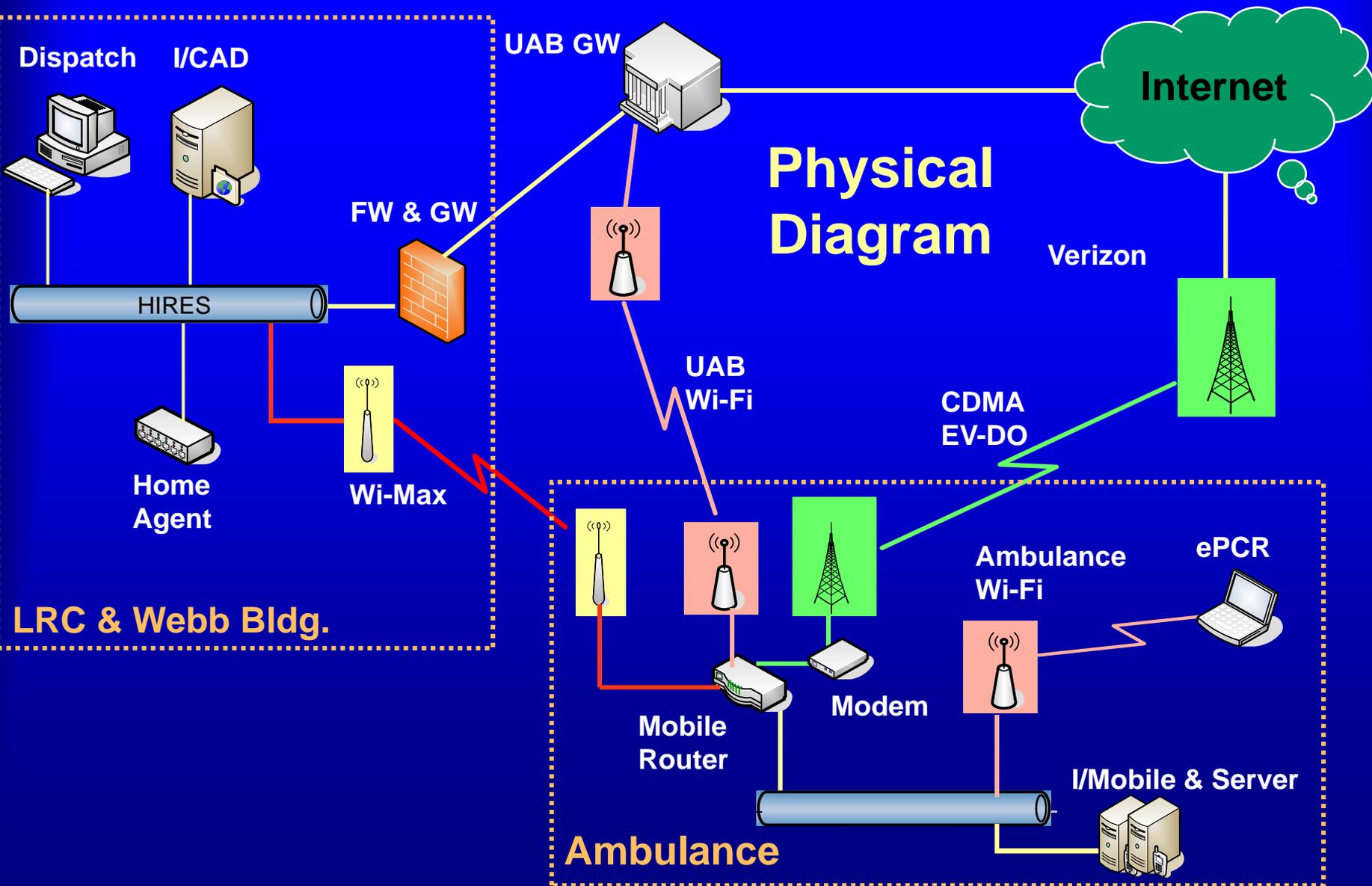
UAB Communications Test Bed

Physical Diagram

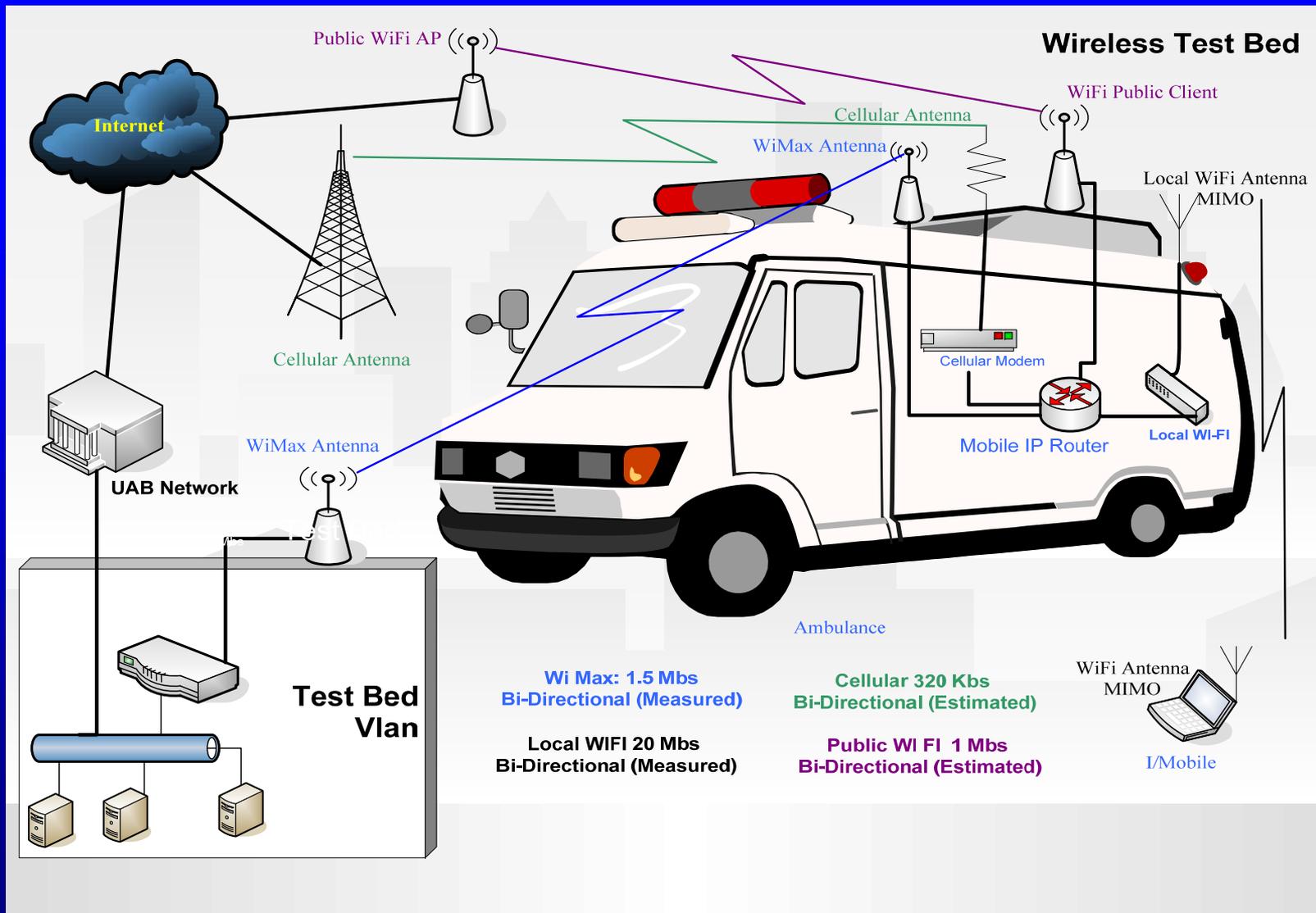


UAB Communications Test Bed

Physical Diagram



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