Panacea's Cloud:

Intelligent Dashboard for Augmented Reality based Co-ordination for Mass Casualty Disaster Triage

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The Need/Importance

- "Time" and "situational awareness" are critical during disaster relief
- Ingenuity of an intelligent dashboard integrated with Internet of Things (IoT) can drastically improve coordination and communication
  - ***Ineffective triage may increase morbidity and mortality***
  - Provides an augmented communication system between incident commanders and first responders in a mass casualty disaster incident
    - Substitutes for limited or absent scene infrastructure

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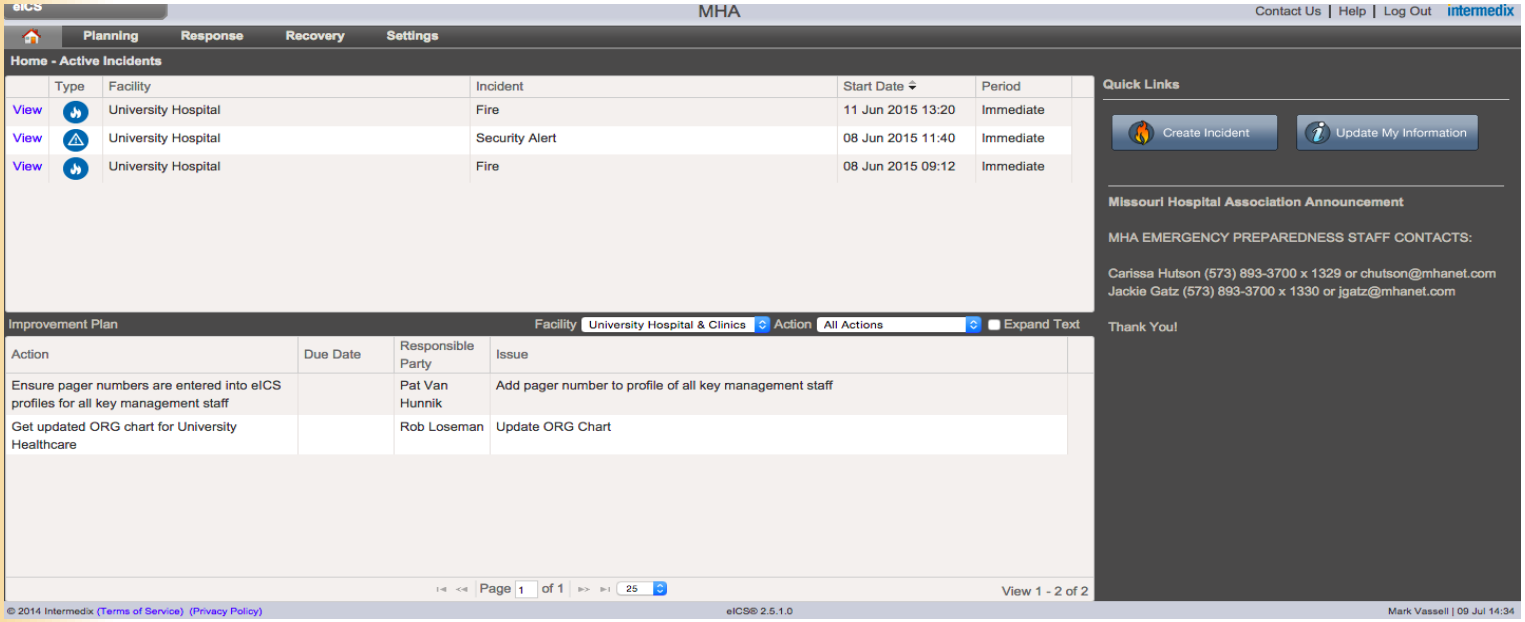
Popular Solution from Intermedix©

- Cluttered and not very user friendly
- No integration of IOT applications or medical systems
- Outdated and limited functionality



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Intermedix Review

- Our University of Missouri institution's protocol named CODE SILVER is based on the hierarchal Incident Command System (ICS), whose technology is provided by Intermedix.
- This system relies on existing operational infrastructure as the communication backbone to coordinate efforts between ICS divisions
- The Intermedix offering is just a text-based web-application for incident response status notifications, and offers basic synchronous text messaging

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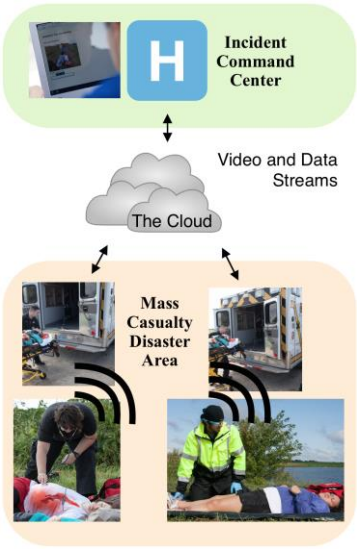
Previous Prototype: Panacea's Glass



- Identified problems
  - Small network area
  - Simplistic Dashboard
  - Google Glass multi-video co-ordination problem
- Decided to improve communication by creating an Intelligent Dashboard – achieve least manual actions
  - Improving Glass communication
  - Integration of virtual beacons

TABLE I: Indoor Range Quality Table

Distance (ft)	Quality	Lag Time Change
1	Great	100%
10	Great	150%
50	Good	300%
80	Good	300%
100	Acceptable	300%
160	Unusable	Infinite (Disconnected)

TABLE II: Outdoor Range Quality Table

Distance (ft)	Quality	Lag Time Change
1	Great	100%
10	Great	100%
50	Good	100%
80	Acceptable	200%
100	Poor	250%
110	Unusable	Infinite (Disconnected)

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New Solution: Panacea's Mobile Cloud

- Responder Theater Dashboard
  - Provides an effective way for Incident Commanders to communicate with first responders in a medical incident or natural disaster
  - Works without dependence of any scene infrastructure
- Easy-to-use interactive interface
  - Incident Management
  - Patient Status Tracking
  - Supplies Replenishment
  - Responder Co-ordination
- Incident Commander can quickly assess any part of the dashboard and give aid to staff on the scene
- Comprised of an Incident Command System (ICS) with integration of Internet of Things (IoT)

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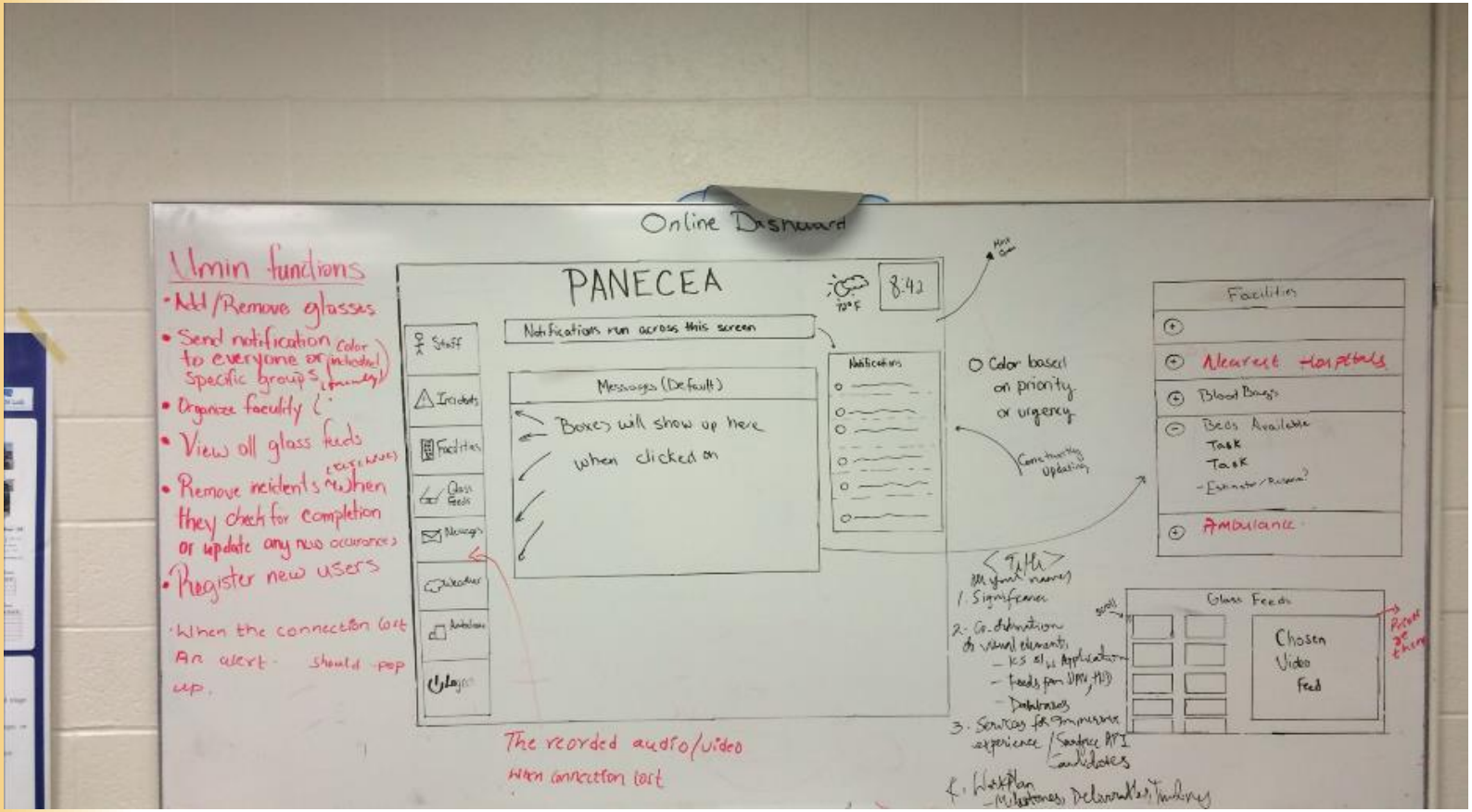
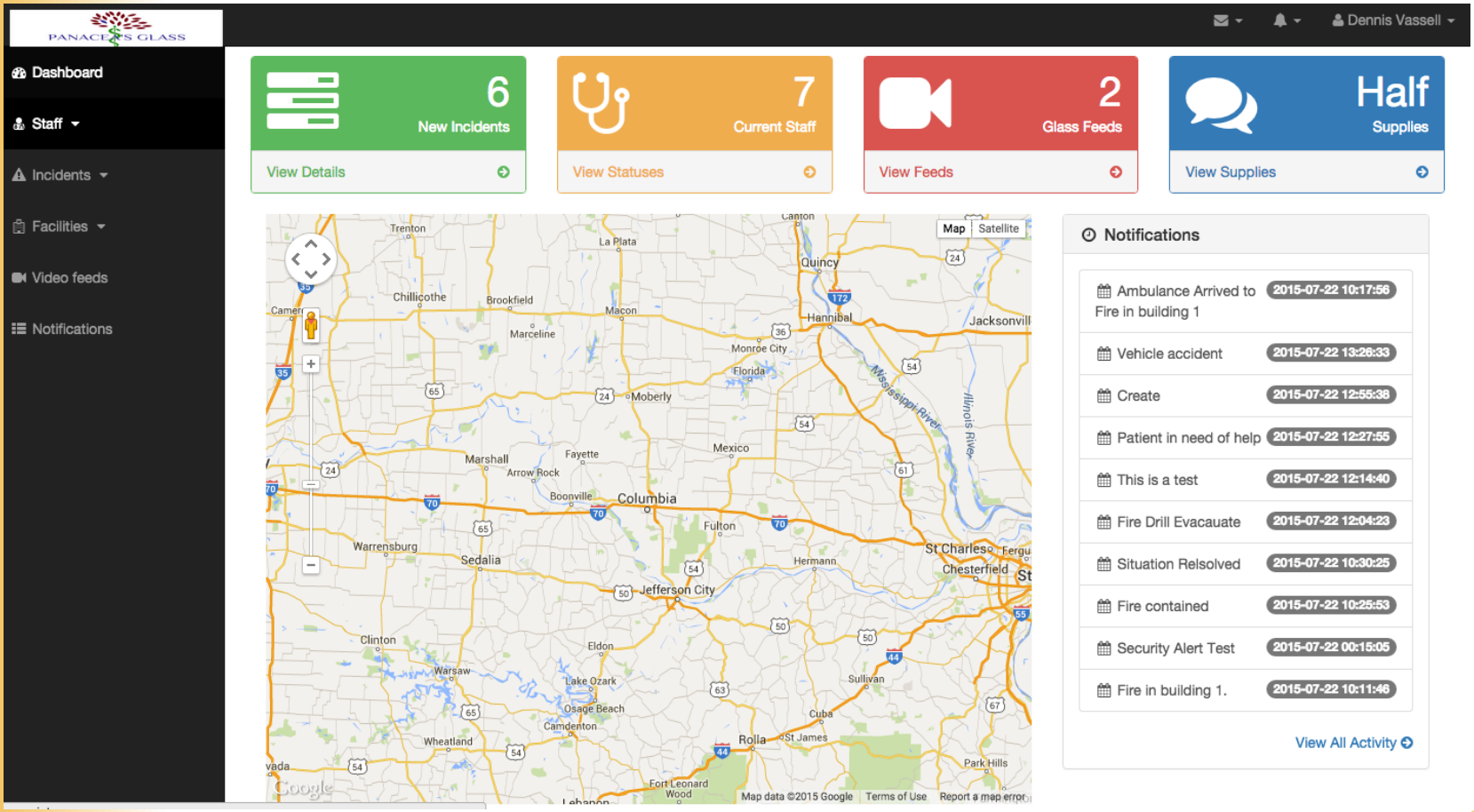
Dashboard Brainstorming



Our NEW Responder Theater Dashboard



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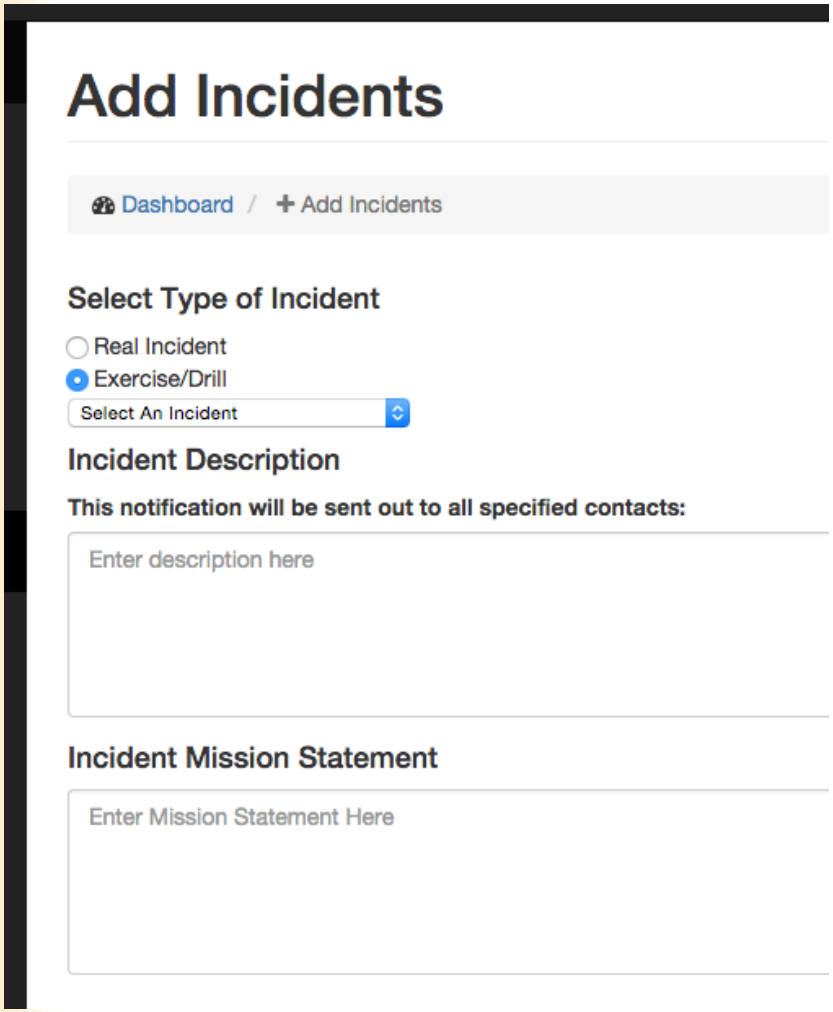
Add Incident



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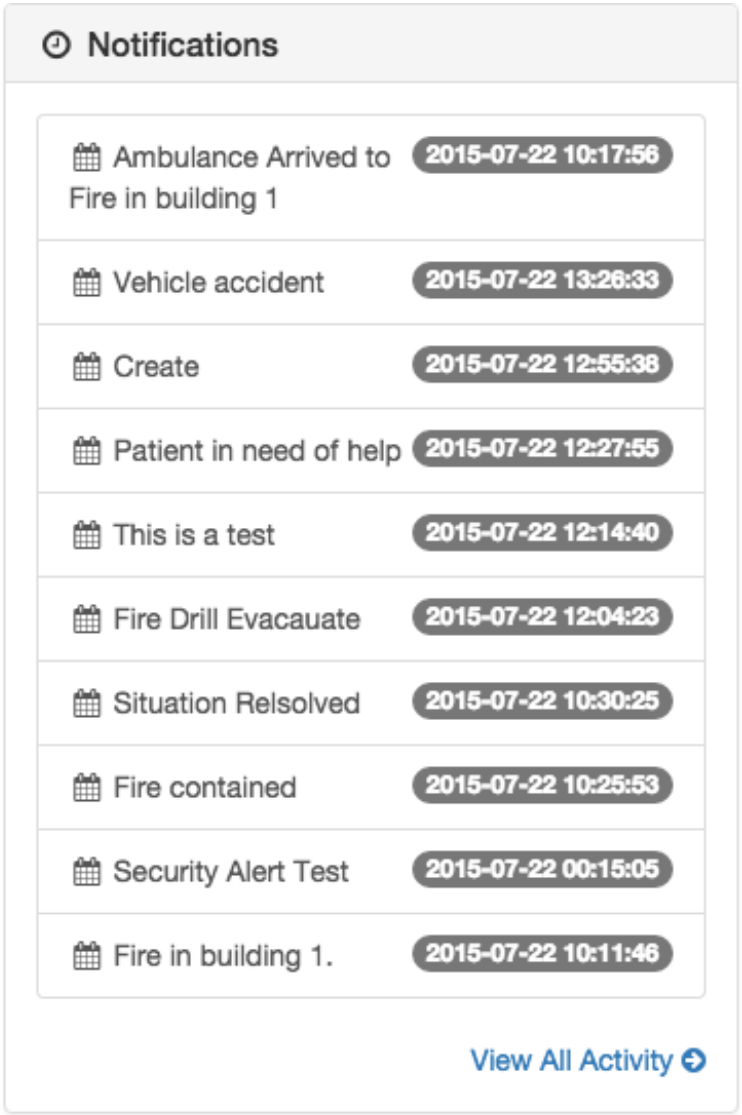
View Incident

List of Incidents

Edit	ID	Type	Name	Description	Status	Time
Edit / Archive/Remove	23	Exercise/Drill	vehicle accident	Vehicle accident |pa	Escalating	2015-07-22 13:26:33
Edit / Archive/Remove	22	Exercise/Drill	vehicle accident	Create	in progress	2015-07-22 12:55:37
Edit / Archive/Remove	21	Actual Incident	Patient Surge	Patient in need of help |Solved the incident	Resolved	2015-07-22 12:27:55
Edit / Archive/Remove	20	Exercise/Drill	vehicle accident	This is a test	in progress	2015-07-22 12:14:40

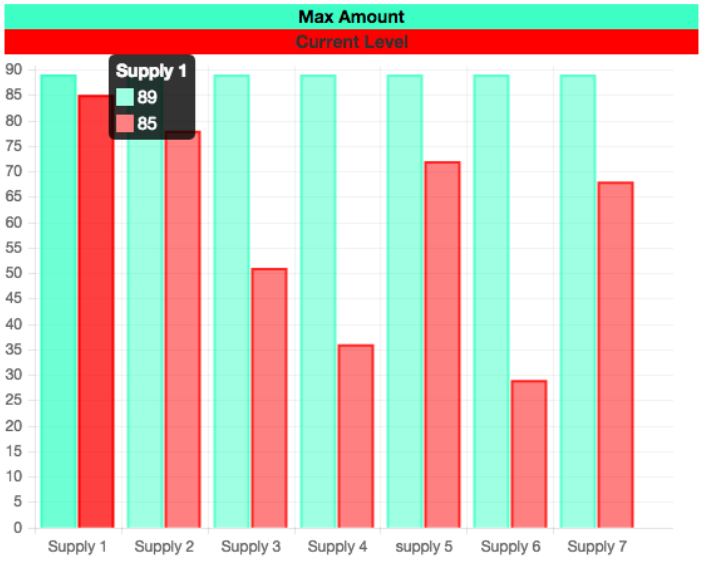
Notifications Page



Facility Supplies Page

Supplies

	Facility Name	Number of Blood Bags	Phone Number
■	University Hospital Building A	24	555-555-55555
■	University Hospital Building B	37	555-555-55555
■	University Hospital Building C	45	555-555-55555



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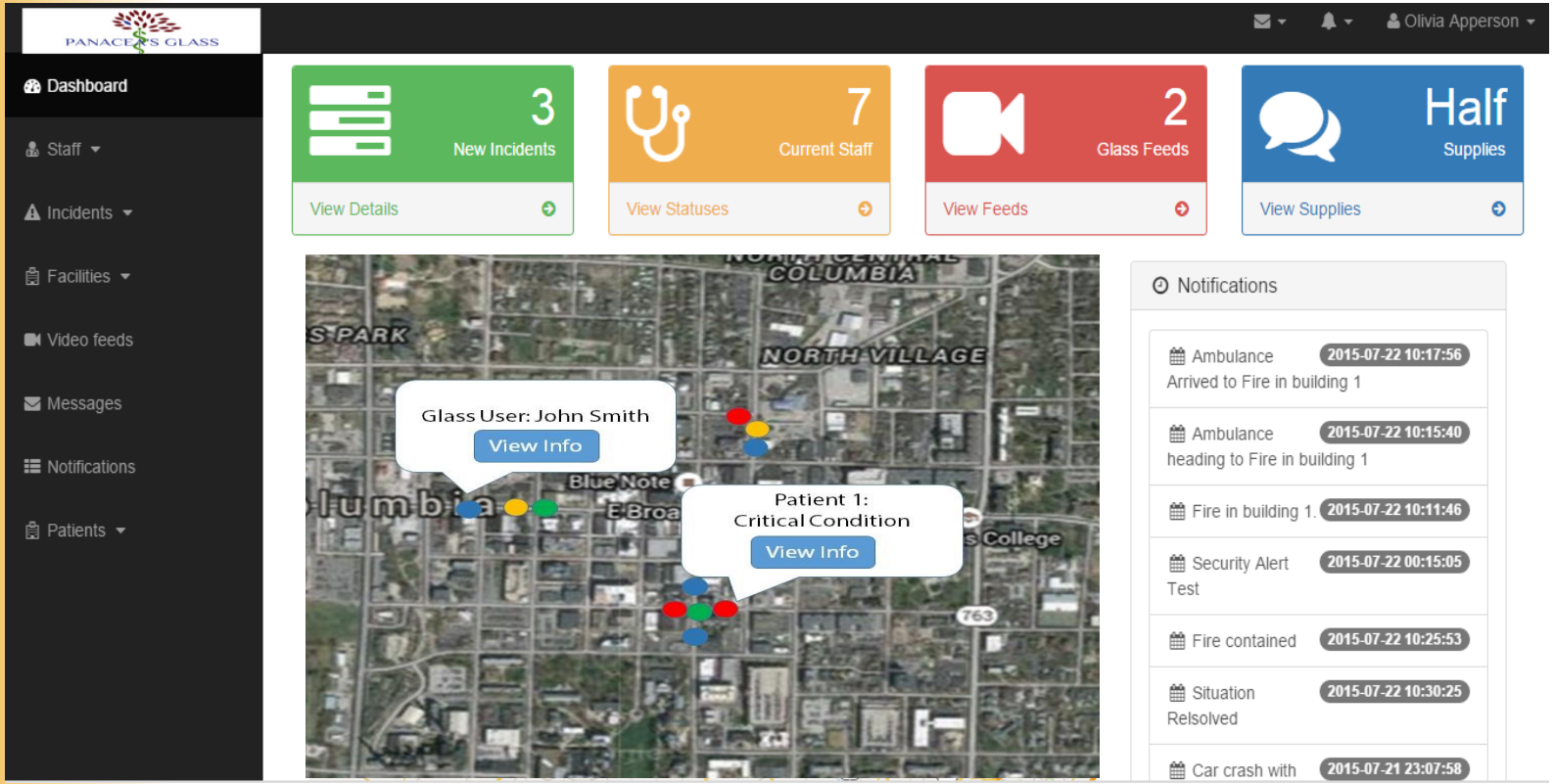
Map



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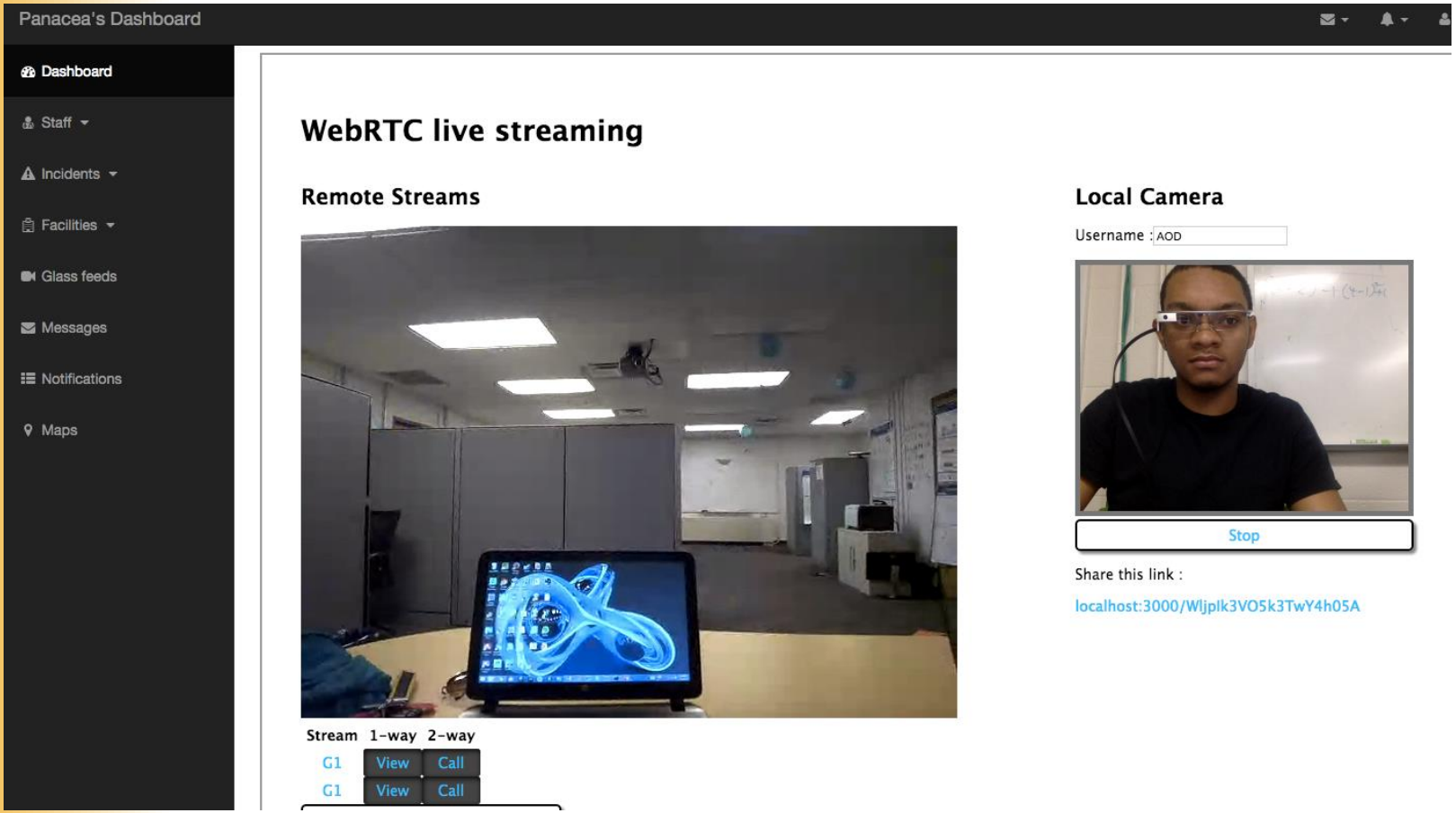
Google Glass Feed Integration



Staff Assignment to Incident

Edit	Status	ID	First Name	Last Name	Email	Telephone	Job	Glass User
Edit Status	Unavailable	10305	Ashley	White	AWhite@health.com	+1 (314) 475 - 7856	Clinical nurse specialist	Yes
Edit Status	Available	10304	Brian	Lee	BLee@health.com	+1 (314) 376 - 9794	Surgeon	Yes
Edit Status	On Call	10306	Jay	Kelner	jKelner@TheJayKel.bis	+1 (888) 888 - 8888	Life Coach and CEO	Yes
Edit Status	Unavailable	10303	John	Hampton	JHampton@health.com	+1 (314) 576 - 9894	Pulmonologist	Yes
Edit Status	Available	10300	Mark	Vassell	mdvy96@mail.missouri.edu	+1 (314) 546 - 3894	Developer	Yes
Edit Status	Unavailable	10307	Mark	Vassell	dvassell@live.com	+1 (555) 555 - 5555	Developer	Yes

- From the staff page the admin has the ability to search for any staff that is stored in the database
- All the information about the searched person will be displayed to the incident commander

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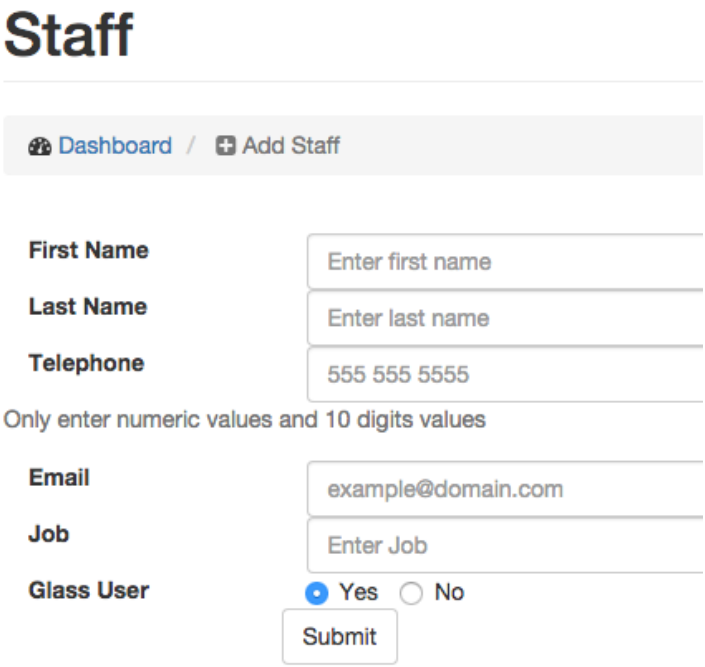
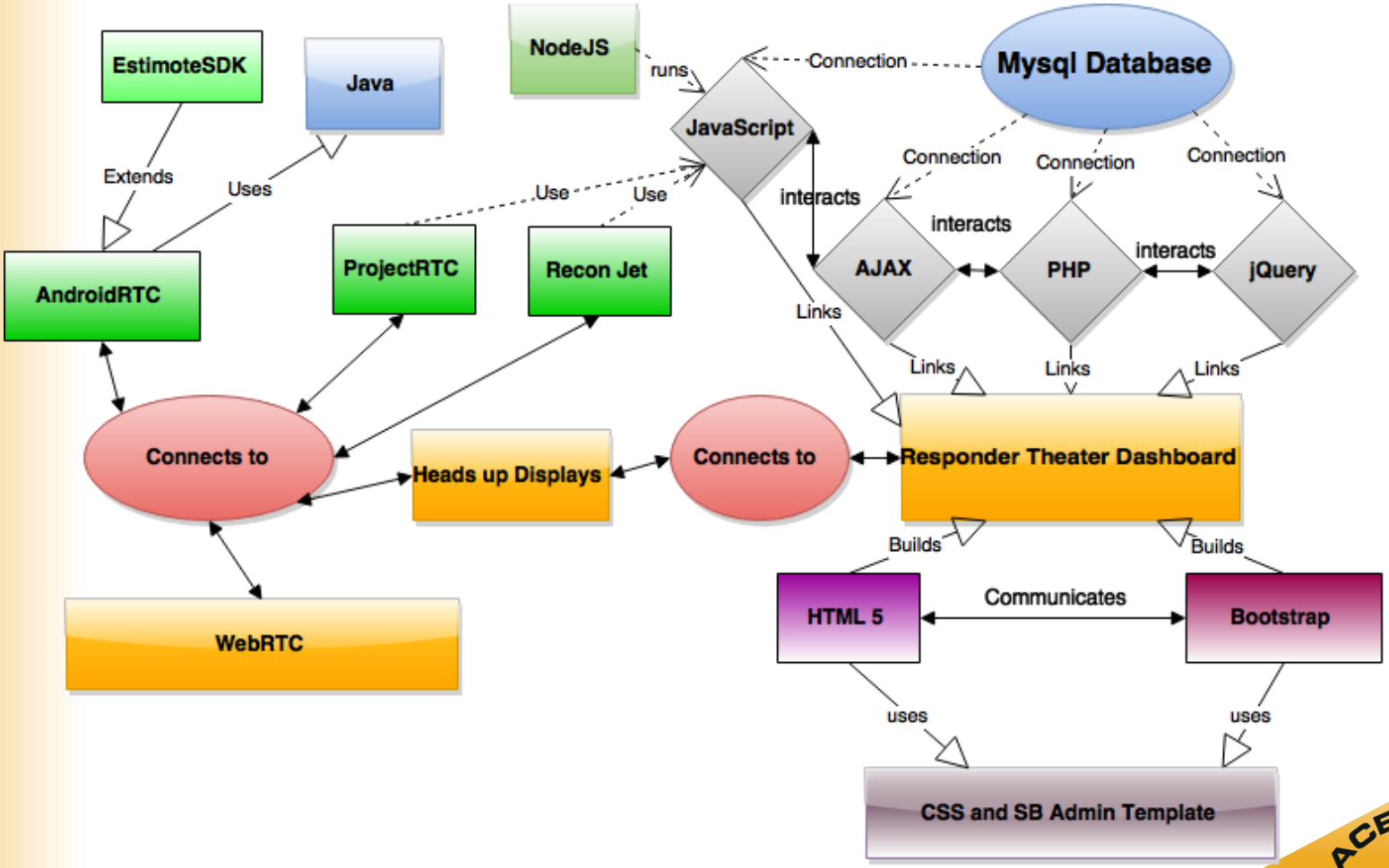
Add Staff Page

- The incident commander has the ability to add new staff to the database
  - Handy when there is an Emergency situatior that will require outside help



Overall Software Architecture



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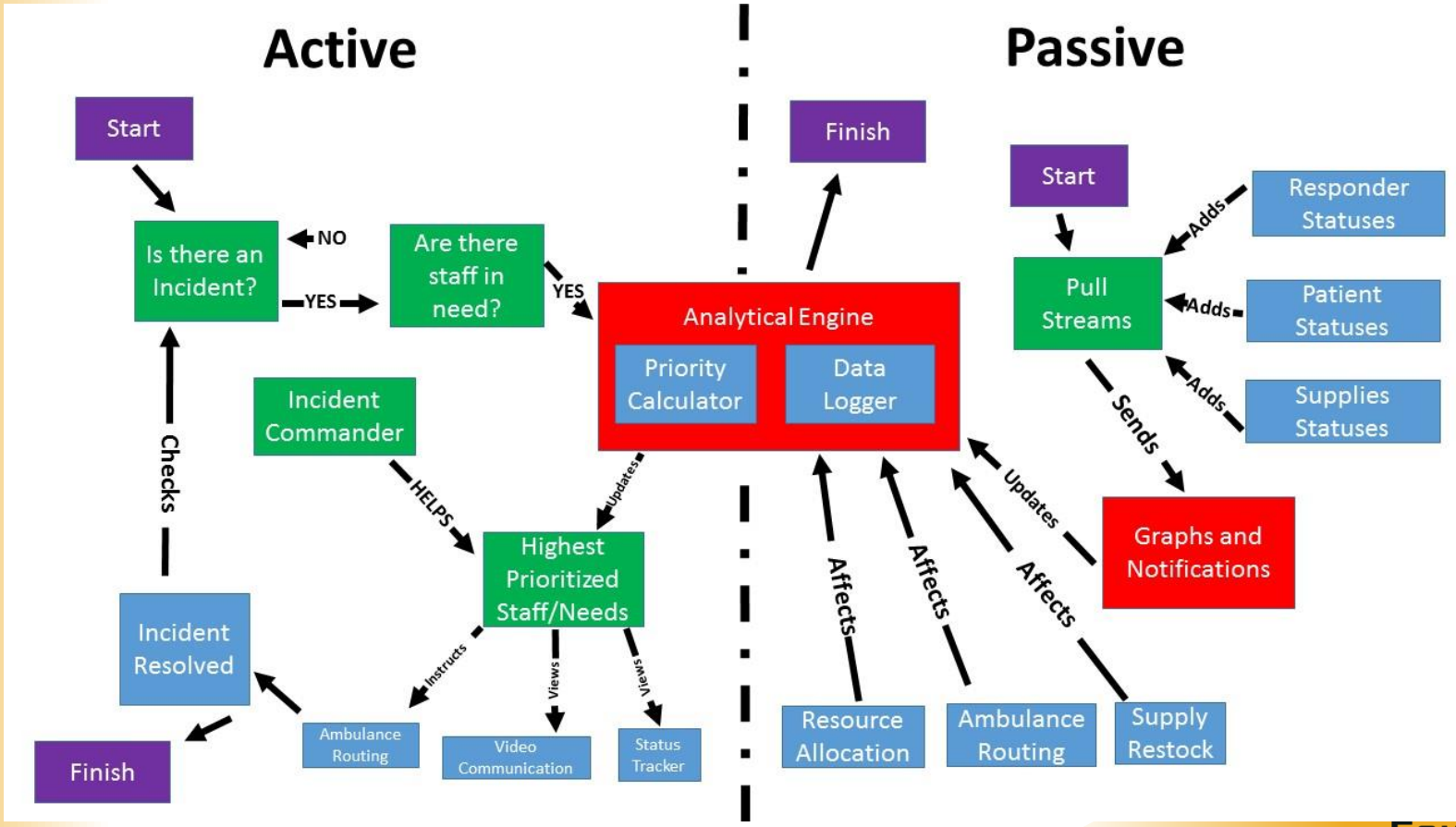
Co-ordination Scheme for Resource Prioritization

- Based on handling the prioritization of personnel and medical supplies between responder stations
- Recommends actionable intelligence for major Incident Commander actions
  - *Active:* orchestration of video feeds between the Incident Commander and First Responders at the scene; ambulance routing tasks
  - *Passive:* Dynamic tracking and replenishment of medical supplies; logging of response activities



Status Trackers/QR Codes

- By accessing the QR code scanner on the glass, staff can quickly change the status of a patient in the database and enable other micro-location based services

Triage Color	Acuity	Need for Treatment	Comments
RED	Emergent	Immediate	Threat to life, limb, or organ
YELLOW	Urgent	Delayed	Significant injury or illness but can tolerate a delay in care
GREEN	Non-Urgent	Minimal / Non-urgent	Can safely wait for treatment
BLACK	Expired or Expected to Expire	No treatment; Expectant: Treat if resources are available, comfort care	Consider transport and care for expectant patients after initial "Reds" are cleared, if resources exist and it does not delay care for Yellows.

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Heat Experiment

- Heat Study:
  - Measured temperatures on Google Glass and Recon Jet during video and audio stream processing
  - Concluded that Recon Jet had a lower temperature and would be more advantageous to use

Wearable Technology	0 Sec.	1 Min.	5 Mins.	10 Mins.
Google Glass	105^{o} F	115^{o} F	130^{o} F	133^{o} F
Recon Jet	90^{o} F	97^{o} F	117^{o} F	124^{o} F

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Connection Experiment

- Connection Study:
  - Tested length of stream connection with Google Glass and Recon Jet in static and dynamic environments
  - Recon Jet did not disconnect for both static and dynamic situations, but Google Glass disconnected

Wearable Technology	Static (minutes)	Dynamic (minutes)
Google Glass	7:59	2:20
Recon Jet	Did Not Disconnect	Did Not Disconnect

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Usability Experiment

- Simulation Study:
  - Incident Scenario: Conducted a two-incident simulation (car crash and building fire) to test co-ordination effectiveness for commander response
- Expert Opinion:
  - Discussed improvements with actual ICS user to provide better communication and co-ordination
  - Test subject concluded that Panacea's Glass Intelligent Dashboard was 'Very Effective' for the claimed purpose!

Section of Panacea's Glass Intelligent Dashboard	Ease of Use (Score 1-5)
Setup and Customization	5
Staff Pages	5
Incident Page	5
Facilities Page	5
Video Feeds	3

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OKR Update

- OKR 1: Create an Intelligent Dashboard .8
- OKR 2: Improve Glass Communication .9
- OKR 3: Learn the Advances in Mobile, IoT Apps 1.0
- Total: .9

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Conclusion

- Successfully created a Responder Theater Dashboard
- Integrated IoT into ICS to create an improved system better than the market offering from Intermedix!
  - In 6 weeks!! ☺
- Results from Usability Study suggest that incident commanders and first responders can successfully augment their triage of patients and resources using Panacea's Mobile Cloud technologies

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Future Work

- Continue to work on project this Fall semester
  - **Will have chance to demo Panacea's Mobile Cloud to MU Chancellor Bowen Loftin @ Coulter Awards Ceremony in September 2015**
- Work on improving the Responder Theater Dashboard
- Do further work on QR codes
  - Turned out to be very critical based on Task Force 1 meeting
- Continue to work on engineering better video communication quality
- Improve path planning algorithm and use in a large-scale simulation demo
- Many more…