Mobile Computing & Cloud Collaboration - Final Project

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The University

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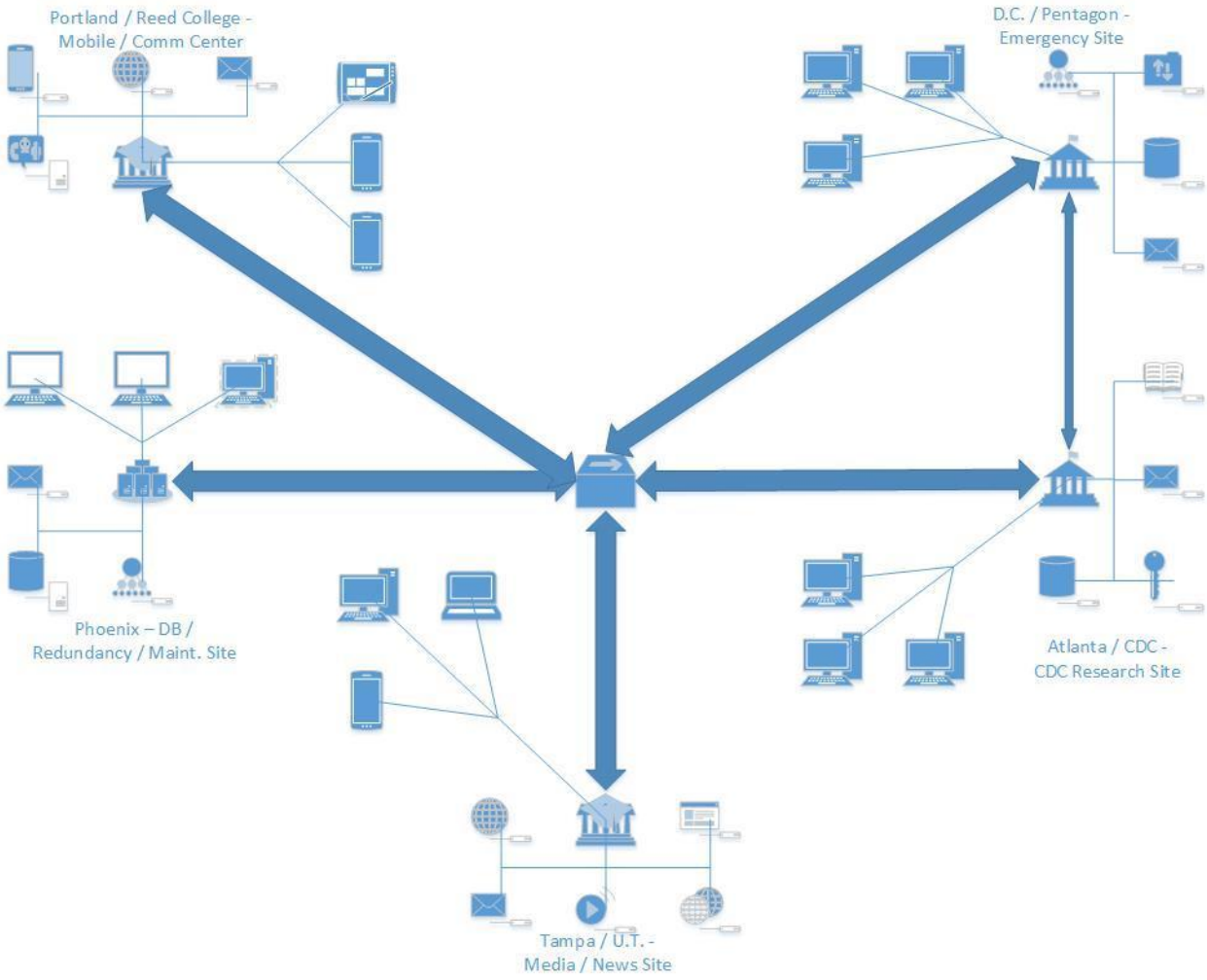
Current / Planned Infrastructure



Portland

The current cluster infrastructure of Emergency Services & Support is a bit dated where certain services are routed through their geographical location vs being available at every city. Portland is the center of mobile services and general communication for the ESS. If the Portland cluster fails, the entire ESS communications fail which is exactly the core reason the ESS exists. This system should be replaced with a Communications-as-a-Service cloud model. Interactive Intelligence offers a CaaS cloud solution offers contact centers from 10 to 50 agents and

PureCloud that works in conjunction with AWS ("Cloud Contact Center – Communications as a Service (CaaS)," n.d., para. 2). Along with in-sourcing employees, their service allows customers to hide and maintain voice paths, recordings, and sensitive data and comes with geographical redundancy to ensure that the ESS communication lines cannot possibly fail (para. 3 – 4).

Phoenix

Phoenix is the center of maintenance, redundancy, and general database storage. While it's good that redundancy is offered at the database cluster, the ESS can't assume that anyone would continue to maintain the database if a national incident occurs. Instead of this particular cluster, ESS can use Amazon's Relational Database Service for database use, geographical redundancy, and storage maintenance. RDS, "manages synchronous data replication across Availability Zones and automatic failover," ("Amazon RDS FAQs," n.d., para. 4) and this use of multi-AZ extends to planned maintenance (para. 133). Since this is a service within AWS, it will work well with Interactive Intelligence's CaaS service, which also highlights the use of geographical redundancy. At least with AWS RDS, ESS can use the cloud for database use, maintenance, and data redundancy without the need for a specific geographical cluster.

Tampa

The consistently great Tampa Bay area is the location of the ESS public news and media service cluster. AWS offers several services that make media streaming, like that of an official news network; easy to use. Amazon S3 offers unlimited storage and access from any location ("Digital Media," n.d., para. 5), EC2 offers myriad instance deployments for encoding (para. 4), and CloudFront offers global content delivery network (para. 6). The current infrastructure depends on ESS hardware and Bay News 9 to deliver any updates. Any needed hardware

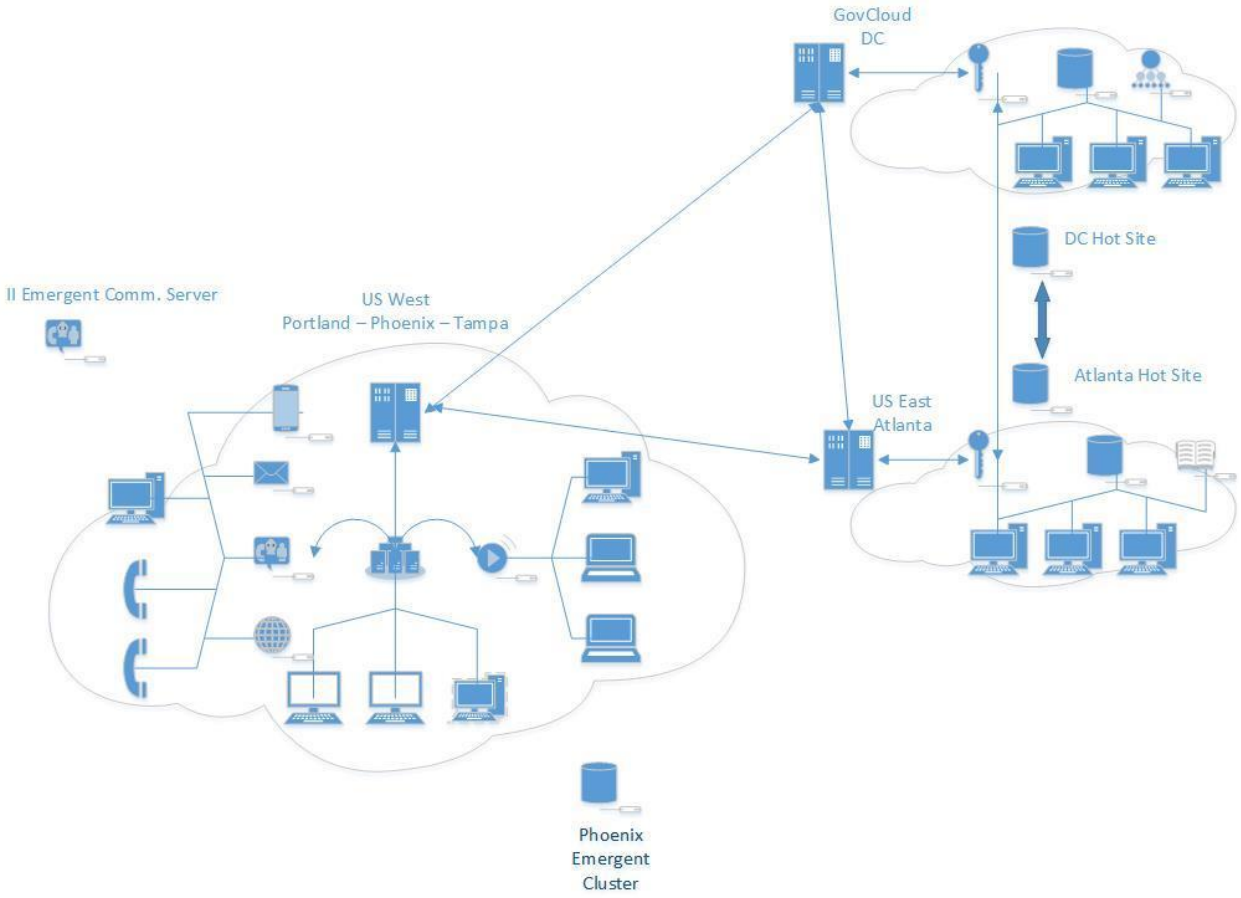
installation could be continued to be done at the University of Tampa to work closely with Bay News 9 since no emergency media-takeover plans have been installed yet.

Atlanta

Atlanta is where the ESS maintains a general redundancy service for the local CDC site. In this regard, it may not be wise to completely migrate this cluster to the cloud since the site is supposed to be a hot site for the CDC in case their own hardware fails. While suggestions could be made to use Amazon S3 in case the ESS Atlanta site fails to retain current data, an additional suggestion would be to use AWS Direct Connect for both the hot site and the active CDC site. Direct Connect (n.d.) allows users to establish private connections between one AWS network, like that of Amazon S3 at either sites, and another location of the user's choice, such as D.C. to immediately alert the Pentagon of any upcoming issues (para. 1 – 2).

District of Columbia

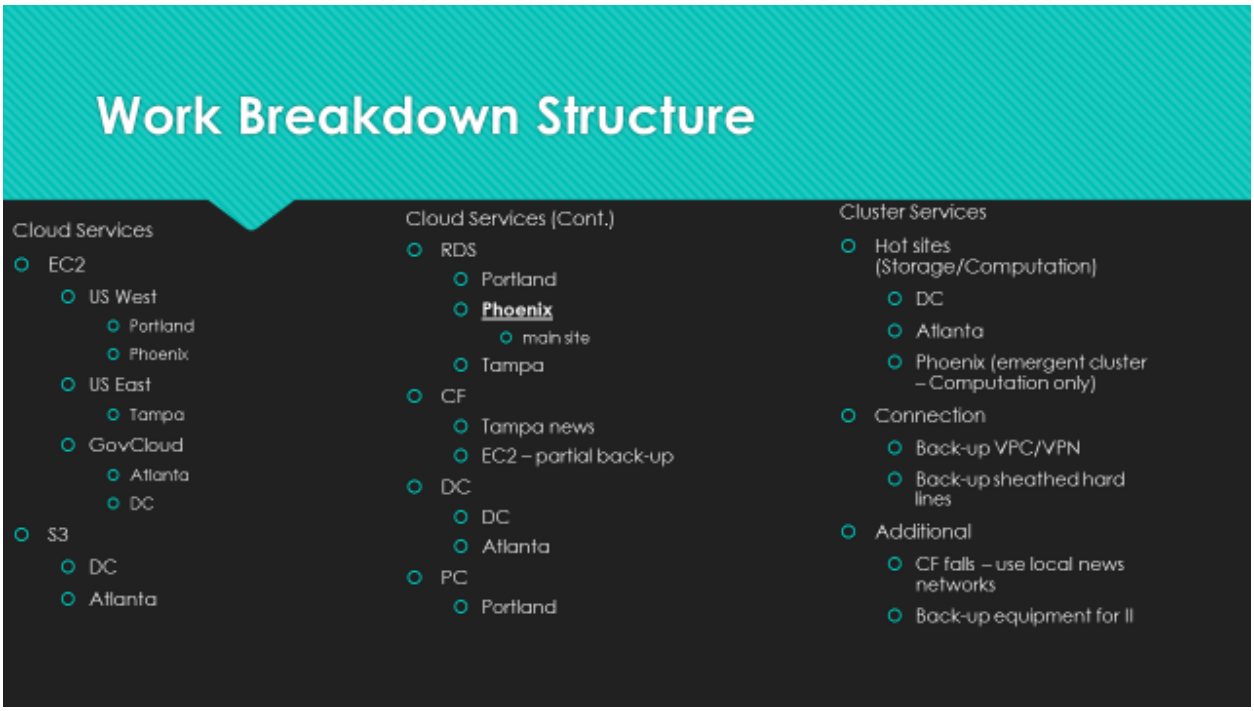
Pentagon site would be the ESS emergency site. Since everything is hardware based and not advanced into a cloud infrastructure yet, the DC site acts as a back-up for any one, or all, site(s) that fail(s) as well as the central location of the ESS. Clusters still have their use, but primarily as back-up or maintenance devices if not constantly run. DC is the epitome of why cloud migration would be needed since it already acts as the emergency cluster for all other sites. If any one site fails, instead of the burden being solely on DC, it could be shared with Amazon's EC2 and Auto-Scaling services where certain hardware clusters like Atlanta could still retain their purpose. That said, the updated infrastructure should look like this:



Work Breakdown Structure

As previously stated, the ESS will need to employ EC2 instances at the US West region(s) with Portland and Phoenix, US East with Tampa, and GovCloud with Atlanta and DC. The main priority of storage with an emergency communications and services system is for the CDC and Pentagon at Atlanta and DC while Phoenix, the maintenance and non-national-threatening emergency site, has priority of database use in communications with Portland and Tampa. Tampa will need CloudFront for media news streaming and the reliance of its own EC2 instance as partial back-up and local news for practical back-up. Portland will need PureCloud to handle the ESS cloud communications for all emergency calls and will thus give Interactive Intelligence the current hardware at the Portland and Tampa sites as back-up since both sites will

not need additional hardware in conjunction with cloud services. The sites that will retain hardware are Phoenix for computation only and DC and Atlanta in case their EC2 and/or S3 instances fail. In addition, DC and Atlanta will maintain current hard line connections between each other, but will primarily rely on Direct Connect to communicate. A VPC will be used in case Direct Connect fails and if the VPC fails as well will the hard lines be used.



Cost Analysis

GovCloud

All sites will use AWS EC2 compute-optimized instances under heavy utilized reserved instances with Amazon Linux at c3.8xlarge. This will cost $9,751 for an up-front 3-year contract for each sites at a total of $19,502 (“Amazon Elastic Compute Cloud (EC2) Pricing in the AWS GovCloud (US) Region,” n.d.). In addition, with the DC and Atlanta sites, there will be use of S3 with reduced redundancy storage that costs $0.0285 per GB for over 5,000 TB a month (“Amazon Simple Storage Service (S3) Pricing in the AWS GovCloud (US) Region,” n.d.). At a

factor for all 3 years, that could cost as much as $5,253,120 per site or $10,506,240 in total. Since the ESS already has existing infrastructure in place, it will cost nothing. However, maintenance is a different issue as well as another departments cost analysis. Both sites will cost $5,262,871 each or $10,525,742 in total. In addition, there's the back-up connections between both sites. AWS Direct Connect costs $2.25 for connection hour for a 10G port ("AWS Direct Connect Pricing in the AWS GovCloud (US) Region," n.d.), AWS VPC costs $0.065 per VPN connection hour ("Amazon Virtual Private Cloud (VPC) Pricing in the AWS GovCloud (US) Region," n.d.), and any hard lines cost nothing new since they're already in place. Since the three would be ran 24/7, the cost of Direct Connect would be $59,130, the cost of VPC would be $1,708.20, and the cost of hard lines would be deferred to the electrical department. The total cost of these connections would be $60,838.20 and thus the total cost for GovCloud for every three years would be $10,586,580.20.

US West / East

The cost of EC2 with Portland at US West (OR), Phoenix at US West (CA), and Tampa at US East will each cost $8,126 for a 3-year up-front contract with heavy utilization reserved instances that use Linux and are compute optimized ("Amazon EC2 Pricing," n.d.). RDS will be under heavy utilization reserved instances with an up-front 3-year contract under db.r3.8xlarge with multi-AZ and will be mainly focused at Phoenix, which would cost $42,640 as well as $0.276 per GB per month of multi-AZ SSD storage for $10,418,651.10 for 3 years of 1PB per month. The cost of RDS at Portland at Tampa will each be $33,056 ("Amazon RDS Pricing," n.d.). The back-up clusters and storage would cost nothing since ESS already owns them, but it would also cost nothing to buy Interactive Intelligence additional equipment for back-up use if the hardware at the Portland and Tampa sites could be given to Interactive Intelligence. Again,

the back-up cluster for the Phoenix site is an issue of the electrical department, but would cost nothing in obtaining since already owned. PureCloud's CaaS costs $4.90 per IP per month and at a rate of 10,000 IPs for 3 years, the cost would be $1,764,000 (Rashid, n.d., para. 4). AWS CloudFront costs $0.06 per GB per month with 100TB per month, which costs $221,184 over 3 years ("Amazon CloudFront Pricing," n.d.). In total, the Phoenix site would cost $10,469,417.10, the Portland site would cost $1,805,182, and the Tampa site would cost $262,366. All in all, cloud migration with selected hardware server farms would cost $23,123,545.30 for 3 years for the ESS to cover all emergency communications and systems for the US.

Sites	Services	Pricing
Atlanta - GovCloud	1) EC2	$9,751.00
	2) S3	$5,253,120.00
	3) Back-up Cluster	$0.00
	3) Back-up Storage	$0.00
	Total	**$5,262,871.00**
Atlanta / DC - GovCloud	1) Direct Connect	$59,130.00
	2) Back-up VPC/VPN	$1,708.20
	3) Back-up hard lines	$0.00
	Total	**$60,838.20**
DC - GovCloud	1) EC2	$9,751.00
	2) S3	$5,253,120.00
	3) Back-up Cluster	$0.00
	4) Back-up Storage	$0.00
	Total	**$5,262,871.00**
Phoenix - US West (CA)	1) EC2	$8,126.00
	2) RDS	$10,461,291.10
	3) Back-up Cluster	$0.00
	Total	**$10,469,417.10**
Portland - US West (OR)	1) EC2	$8,126.00
	2) RDS	$33,056.00
	3) PureCloud	$1,764,000.00
	4) Back-up Cluster	$0.00
	5) Back-up Storage	$0.00
	Total	**$1,805,182.00**

Tampa - US East	1) EC2	$8,126.00
	2) RDS	$33,056.00
	3) CloudFront	$221,184.00
	Total	**$262,366.00**
		$23,123,545.30

Risk Analysis

Business Impact	Likeli-hood	Severity	Level of Control	Significance (Likelihood + Severity+ Level of Control)	Risk Strategy	Risk Mitigation Plan
Atlanta/DC hot sites may not compensate. If only single, shift over to another location. II CaaS will remain for 911 support. Any serious community wide or larger threats will be an issue.	1	5	3	**9**	Transfer (1 or 2 fail) / Control (all fail)	Maintain hot sites at DC / Atlanta sites and one emergent cluster at Phoenix site
ESS wouldn't be viewed as reliable anymore and may cause serious issues since S3 would be used for Pentagon and CDC.	3	5	1	**9**	Transfer	Repeat - maintain hot sites at DC / Atlanta, which are the 2 of 5 sites that will use S3
Storage maintenance, geographical redundancy, and database access would be temporarily hindered if Portland/Tampa or permenantly if Phoenix.	1	3	2	**6**	Assumption	Additional RDS services would other CSPs could be used. For cost efficiency, ignore until fails.
Content delivery would have temporary performance issues until picked up automatically with EC2 and S3.	1	1	2	**4**	Transfer	Since CF is used as ESS news, utter failure could still be managable by relying on actual news networks
DC/Atlanta would have to rely on open communication that could be secured with extra effort or hard lines that two would have to be maintained and secured.	2	3	1	**6**	Transfer	Back-up VPC with VPN tunneling and heavily sheathed and hidden hardlines would be best. A contingency with a contingency.
ESS wouldn't be able to function at all. Dependency on local hardlines would do too little.	1	5	5	**11**	Avoidance	Provide II any emergent equipment to ensure no failure occurs.

EC2 / PureCloud

The ESS faces 6 large service-specific risks if, after everything previously stated, the ESS plans to progress with cloud migration. The first is AWS EC2. If all 5 sites' instances fail, the whole infrastructure fails, but if only one or two fail, services can be shifted onto another sites' instance. This the reason for hot sites and back-up clusters. The Atlanta and DC sites should maintain their own hardware in case EC2 fails, Phoenix should maintain a compute-only cluster, and Portland should still be capable of handling 911 calls. If PureCloud fails, emergency national communications would be down, but not local. In the instance of that this happens, ESS wouldn't be able to function on its sole purpose and depending on local lines wouldn't be sufficient. Since no hardware would be needed at the Portland or Tampa sites, it may be best to transfer the equipment to Interactive Intelligence in case their own hardware fails.

S3 / RDS

S3 is to be used at the DC and Atlanta sites while RDS is to be used at the Phoenix, Portland and Tampa sites where Phoenix will maintain RDS. If S3 fails, redundancy fails, data becomes corrupt, records may be lost, and any unsaved progress will be gone. ESS would be viewed as incompetent and thus is an issue as large as EC2 failure and almost as large as PureCloud failure. As previously stated, DC and Atlanta will maintain their own clusters and storage just in case. If RDS fails at the Phoenix site, redundancy and storage will fail all together, but if only at Portland and/or Tampa site(s), failover to the Phoenix site will occur. This isn't likely to occur and additional database services for back-up use would cost too much so it's best to ignore until an issue arises.

CloudFront / Direct Connect

If CloudFront fails, the primary media news streaming would fail. This is the least important risk as the Tampa site could rely on its own EC2 instance for partial support as well as local news Bay News 9 for any emergency news broadcasting. If Direct Connect fails, private two-way communication via cloud between DC and Atlanta would be down. This is a big issue, but several contingencies have already been put in place at both sites so will naturally have several for communications. First, there's the VPC with VPN tunneling. Second, if even the VPC fails, there's heavily sheathed, hidden lines that already exist between both sites. Cloud technology is much easier to maintain and mitigate risks than cluster technology.

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