2013-08-06 FirstNet Public Safety Wireless Broadband Network

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High Velocity Human Factors

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FirstNet Public Safety Wireless Broadband Network: User-Centered Design and Human Factors Driven Engineering of NextGen Public Safety Network

Data, Data, Everywhere...

The New York City Police Commissioner Raymond Kelly testified to Congress last year that "a 16-year-old with a smart phone has a more advanced communications capability than a police officer or deputy carrying a radio."

10-4 ... Roger that!

And, if I may add, the 16-year old revels in the data deluge delivered by this "advanced communications capability": Facebook, Twitter feeds, IM, SMS, YouTube, Spotify, and you name it! The young man or lady is socially connected, entertained and is up to speed with the goings-on in his/her social network. But how well does this apply to a mission critical, first responder such as a police officer, fire fighter or paramedic?

There is no doubt about the need for an advanced communications capability for first responders. However, the first responder doesn't wish to be drowning in a data deluge that is devoid of immediately useful and actionable information or intelligence. His refrain would be "data, data everywhere, but where is my byte that matters most???"

Simply put, our mission critical professional has no time to google, mapquest, tweet or watch a video. In other words, a first responder on call doesn't have the time to:

- google to figure out the nature of the domestic violence incidents at a particular house
- mapquest a street in response to a fallen colleague's mayday call broadcast to get there within the "platinum 10" [minutes] and provide basic life support.
- tweet during a hot pursuit to warn citizens that a fugitive is driving at high speed on the wrong side of a highway
- watch a video-tutorial to compare the situation on hand and receive guidance on delivering advanced life support / antidote to a grievously poisoned citizen.

Drowning in Data, But Where is the Information?

Obviously, the public safety communication infrastructure and the subscriber units (the handheld 2-way portable radios and vehicle-based mobile radios, data devices, computing technologies, etc.) used today do not have the bells and whistles of an iPhone. Or to go back to Police Commissioner Kelly's analogy, they are unlike the 16-year old's smart phone with processors and chipsets generating bewitching animations -- and more importantly pumping unlimited data from a fat pipe (a 4G LTE wireless broadband network).

But in the process, what we also forget is the fact that the 16-year old is enjoying his streaming music and emitting his tweets when his commercial-grade wireless network is standing like the Rock of Gibraltar. For example, it has not been physically attacked, virtually hacked or brought down by peak demand due to a natural disaster or terrorist attack. Furthermore, the 16-year is doing all this in a threat-free situation, where his heart rate is not surging or the adrenalin and cortisol (stress hormones) are not coursing in his veins, prepping him for a fight or flight response. The good young man is neither in the situation of a hotshot surrounded by a raging forest fire nor is he a paramedic trying to figure out the best way to stop an arterial bleeding of an accident victim with a punctured lung and fractured vertebrae.

Enough said!

A first responder is unlike you and me, the consumer. More often than not he is functioning in a system that is in non-equilibrium, where High Velocity Human Factors or **"HVHF"** comes into play.

On to Mission Critical / Public Safety Communication

The evolution of public safety communication networks (APCO P25 in North America, Figure 1; TETRA in Europe) have been slow from the days of the analog conventional radios that were so large they could only fit in the trunk of a car. But over the years they acquired the traits of the Rock of Gibraltar: hardened and solid in terms of survivability; reliability; security; velocity of voice comms. For example, they have

redundancies built into the base station and site controllers so that a single point failure doesn't take all communications down. And they are catching-up with their cousins in the defense space (JTRS: Joint Tactical Radio System): where the network is not only resilient but intelligent (self-healing and self-connecting networks; cognitive radios with programmable wave forms, which might change attributes on the fly depending on the communication link: rifleman to manpack radio in an Abrams Tank, or from from a Humvee to recon aircraft hundreds of miles away.)

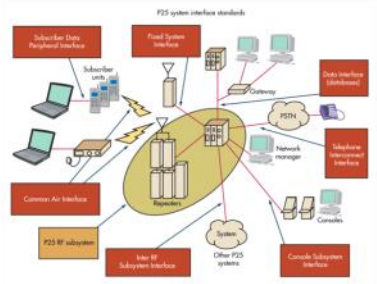

Figure 1: The APCO P25 communication network was a major step towards standardizing disparate communication systems via a CAI (Common Air Interface), which was also backward compatible (worked with legacy analog, conventional systems), with the goal of promoting interoperability
(Source: Electronic Design)

Public Safety comms. have their weaknesses as well, the biggest one being lack of interoperability as they are fragmented, unconnected and constrained due to technology, jurisdiction and inter-organizational cultural impediments. Say, the Fire Department in County X may not be able to communicate with the one in County Y. Put in consumer-communication speak, if you are a Verizon subscriber from New York visiting Miami, you can't call the local restaurant because they subscribe to AT&T Wireless and land line telephony.

FirstNet: Sociotechnical-based, User-Centered, Human-Engineered NextGen Public Safety Networks

A brave new initiative called FirstNet -- a rugged, public safety-grade broadband wireless network -- seeks to retain the strengths of existing public safety communication networks but overcome its weaknesses (from lack of interoperability to the narrowness of its data pipes) is in the works.

The design and deployment of FirstNet, including the subscriber units (portable radios to mobile computing technologies), have to considered with great care so that it delivers both utility and usability. This is no casual communication; life and limb are often on the line.

Thus the goal here is not to drown the first responder with data because one has gotten hold of a fat pipe (broadband wireless network). In fact, for some mission critical use cases, (a data deluge) more data maybe worse than no data! Simply because, the constant data pings and voice chatter may distract the first responder from his primary task of saving someone. Remember HVHF! Under stress he has limited cognitive resources and they are precious. He needs to put all his attention and cognitive effort in either focusing on the threat or putting out a raging fire. He has no mental bandwidth left to idly monitor the goings-on in his network or surf the data that his streaming through his device.

To get mission critical *communication* design right, let's first, well, get to first principles.

What is *Communication*?

In its simplest form, communication results in the transmission of information, from a transmitter, with the goal of making the Receiver aware of something that he would otherwise be ignorant of (Figure 2). Ideally speaking, the integrity of this communication should not be compromised either while being encoded (transmitter-end) / decoded (receiver-end), or due to "noise" (garbled) by a weak signal or cross-talk. Here are three examples of mission critical communication:

- First responder at the accident scene communicating to dispatch; "Life threatening injury; need paramedics and transport to Level 1 Trauma Center."
- Police officer after pulling over a vehicle [accessing data]: Interrogating a remote database for driver's license and registration information.
- Accident Investigator: [video] Recording and transmitting video (evidentiary information for forensic analysis and/or to be used in court).

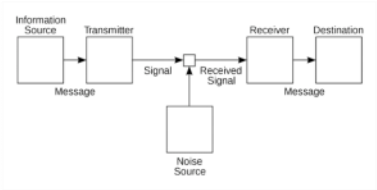

Figure 2: Mathematical Theory of Communication (cf. Claude Shannon)

Communication -- be it one-way, two-way, multi-way (conference call style, a.k.a., "TalkGroup" in public safety comms.) -- is all about context: e.g., seeking immediate rescue; enhancing situation awareness to prevent friendly fire; or enable sensemaking in a complex wildland firefighting scenario.

Thus communication, particularly one that is technologically enabled, to be successful needs to consider the social & organizational context; users' information and communication needs; and human cognitive & physical capabilities and limitations. These are discussed next.

Socio-technical System (STS) Based

Consider a major natural disaster such as Hurricane Sandy. Several entities from FEMA, federal to local government agencies coordinate emergency management, search and rescue. When designing a comm. network, one has to take into consideration the intra- and inter-organizational factors among the various government agencies, in deciding, planning, collaborating and managing their work. This may encompass written procedures, trained responses, tactics, techniques and procedures, politically and legally mandated protocols -- and last but not least cultural factors (good and bad).
As an example, FEMA's incident command system (ICS) is a scalable and manageable command and control system with the goal of integrating local, county, state, and federal assets to provide the most effective first response from a category IV Hurricane to a terrorist attack.

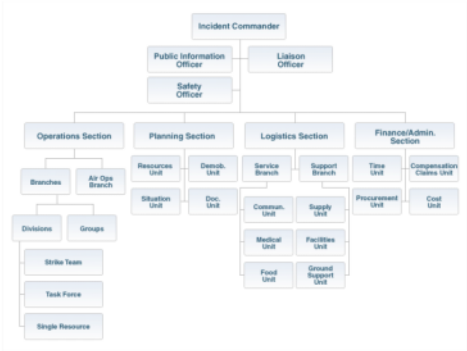

Figure 3: Incident Command System

As seen above, a fat pipe (broadband) may be a necessary but not a sufficient solution for effective communication. It needs to be *agile* so that it either self-configures (or is easily configured by a technician) on the run in real time (by recognizing the infrastructure [base station, site controllers, repeaters, etc.] and, last but not least, the plethora of subscriber units, which could range from portable radios, mobile computers, including consumer tablets and smart phones (BYODs); It must be *intelligent* and know what and which type of voice or data traffic to prioritize; It must be *adaptive* to the situation on hand so that it morphs (e.g., cognitive radio) to exploit the available RF spectrum to deliver *connectivity* on the ground to into the cloud.

PLUS, the network should be hardened and have all the required attributes for public safety grade communications: survivability, reliabiity, security, interoperability, etc.

User-Centered Design

Consider a sampling of mission critical professionals: A hotshot battling a wildfire in a gulch, an EMT providing basic life support to a gunshot victim, or an officer with a search warrant have different goals, situational context in which decisions have to be made and informational needs.

- The hotshot serving as a lookout may require live meteorological and topological information and needs to be networked with the central command and his cohort, hotshots on the fireground;

- An EMT may have to look-up electronic health records of the victim for any pre-existing health conditions and contraindications and be in touch with the receiving ER physician;
- An officer with the search warrant who has descended to the basement might find himself cornered with no network signal and, thus, has to use Direct Talkaround to his partner in the floor above to summon help.

Thus the information ecosystem and the communication networks shoud be user-centered in terms of delivering useful, usable and actionable intelligence in realtime to the mission critical professional. They could either be delivered on demand or with predictive analytics that carefully sifts through data to deliver useful and situationally relevant information.

Human Factors + Ergonomics + Cognitive Engineering

This final piece concerns the mission critical professionals themselves: the human operators, their physicial / cognitive capabilities and limitations; and how they have to be integrated into the public safety communication socio-technical system. There are several layers to this integration, and one of them is the human-machine interface (HMI), also known as UI (user-interface). This covers both the physical (knobs, buttons, keys) and graphical user-interfaces (information architecture and human-computer interaction design) on the devices with which they interact: handheld / vehicle-mounted radios, tablet-computers, command & control computers, etc.

Whether it be a normal operational situation or an emergency, and, thus, an abnormal situation, the user-interface for any and all technology should be intuitive and usable. Furthermore, depending on who the mission critical user is -- e.g., front line first responder, commander or network administrator -- it should as an useful cognitive interface as well: augment their senses and deepen their comprehension of what is going right or wrong in the mission-space. This is critical, because they are the first and last line of defense with regards to protecting precious assets, from human lives to property.

The Fat Pipe Filtered: *Data* to *Information* to *Knowledge*

A communication network (Core to Nodes to Subscriber Units) when designed by applying an STS-based, user-centric, and human engineered approach gets its closer to the ideal solution -- where technology is used to amplify human capability. Simply put both the technology and human agents in the STS should work as peers and partners -- a joint cognitive system -- to produce best results. In other words, when an algorithm fails to provide the answer when confronted with a novel situation a first responder may solve it with his sudden flash of insight. On the flip side, the technology maybe the best handyman when a sensor, search and analytical engine does what it does best: connecting an automatically scanned license plate to a stolen car, or using facial recognition technology to recognize the face of a man who is wanted for hacking ATM machines in a different state.

It is good to be gung-ho about new, better and faster technology. But technology should not be celebrated for technology's sake. So let me summarize what I have discussed so far in this article in the context of FirstNet, the public safety broadband network being designed in the United States:

> The purpose of FirstNet is to deliver actionable information at a high velocity -- which is comprehensible via an intuitive user-interface -- and not terabytes of useless data. It must equip and enhance the capability of our public safety professionals. It is a fallacy to entertain the mistaken notion that a Public Safety Broadband Wireless Network will do the first responding and the first responders will be transformed into IT workers who are busy manning the equipment.

About the author:

Moin Rahman is a Principal Scientist at HVHF Sciences, LLC. He specializes in:

"Designing systems and solutions for human interactions when stakes are high, moments are fleeting and actions are critical."

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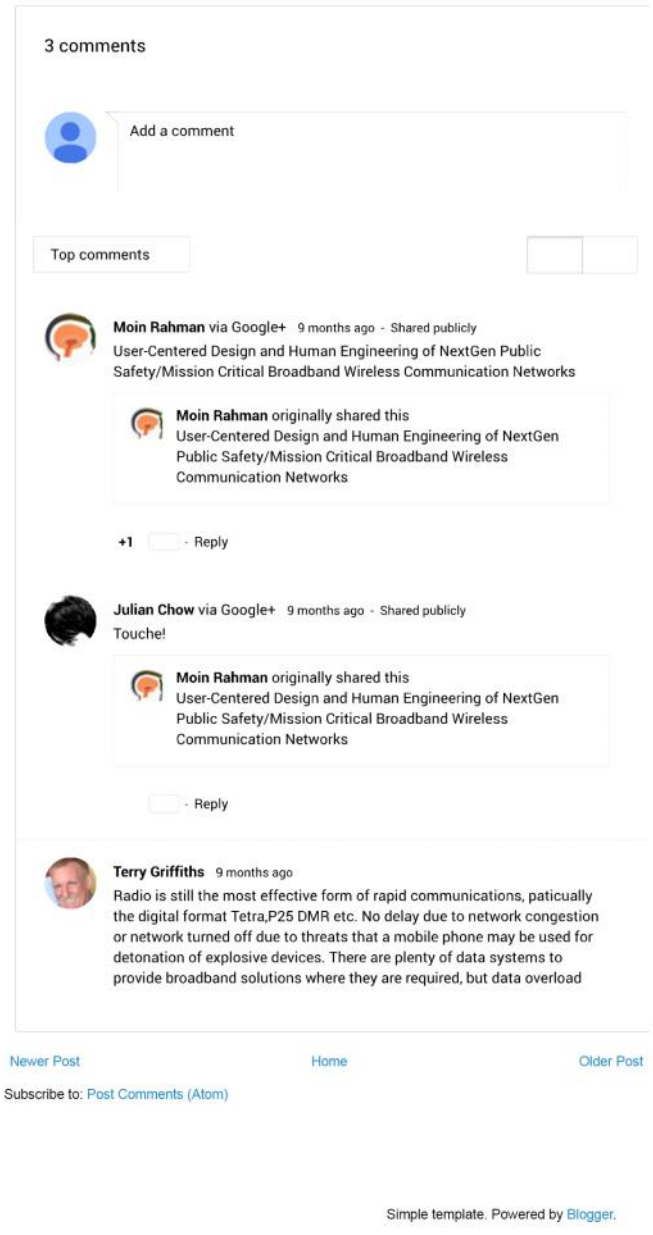
Posted by Moin Rahman at 2:33 PM

Labels: APCO, APCO P25, First Responder, FirstNet, HVHF, Mission Critical, Mission Critical Communication, P25, Public Safety, Public Safety Broadband, Radios, TETRA



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Radio is still the most effective form of rapid communications, paticually the digital format Tetra,P25 DMR etc. No delay due to network congestion or network turned off due to threats that a mobile phone may be used for detonation of explosive devices. There are plenty of data systems to provide broadband solutions where they are required, but data overload

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