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Abstract	`System requirements for 802.16m`
Purpose	Mobility comments from emergency services/military customer point of view.
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IEEE 802.16 standards, and military and emergency services

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Rationale for these comments.

Both emergency services (fire, police, ambulance, etc) and the military are fundamentally mobile services. While they have fixed elements (e.g. command centers), mobility, in all its dimensions, is one of the cardinal differences that distinguish these customers from others. Extending the internet to reach all the way down the command chain to the dismounted infantryman or the individual boarding officer is properly an objective. The last link composition is a subject of considerable discussion with proponents of several technologies.

One other element is the much greater incidence of data that is multicast in nature than in most commercial applications. One example to illustrate: an Army truck in the battlespace needs to report its position periodically. That item of data needs to go many places to be useful.

A final meta requirement needs to be stated: high availability. This is a requirement that, because it is largely met by provisioning, is sometimes understated in protocol discussions. But it is a trumping requirement in emergency services and military systems.

Topology differences.

The Navy has a more advanced case right now, but this topology will become increasingly prevalent. It looks like this: a Navy ship may have dozens/hundreds of end systems within the ship. All tied to a LAN (mostly ethernet today). In the radio room is installed a router with interfaces on the other side to radio-WANs. At far side of the radio-WAN are terrestrial WANs, same as commercial world.

In this case, the radio network is a WAN -- it's in the interior of an internet and has no end systems attached to it -- they're all on the other side of the router in every direction. Note that this topology is parallel to the IEEE 802.16 business model of broadband access to residences, but much more extreme.

Prognosis.

While the Army truck noted above may not have a LAN in it yet, it will. With several end systems attached. Indeed, we are seeing this develop with dismounted infantrymen and the sensors and decision support end systems that they carry today. I recently was part of a discussion on the Navy's P-8A aircraft (maritime patrol, replacement for the existing P-3); it appears that the mission package in the aircraft will probably be networked together with IEEE 802.3 ethernet. And in the commercial world, note that an ambulance has several diagnostic sensors that have need to pass data

Observations.

The networks at all interfaces surrounding the radio-WAN are orders of magnitude more capacious. We can easily assume that the radio-WAN will be chronically saturated with more offered traffic than it can handle. Therefore the stable scheduling MAC in 802.16 is required.

As a great deal of the data is multicast in nature, and given the need to be economical of the scarce resource (spectrum), multicast should be supported.

Mobility is ubiquitous and has impacts at several layers. I've attempted to sort these comments by

layers of the IEEE 802.16 standard (and ISO Reference Model). I'll omit most of the considerations at layers above 2. With the following exception:

Network layer. In some mobility cases, volatile routing topology is the defining characteristic of 'mobility'. Mobile Ad Hoc Networking protocols are aimed at this problem. The reason that it is worth mention here is that this routing volatility can also be attacked at layer 2 with various bridging solutions. There's a catch here: if, for example, the 802.1 spanning tree solution is implemented it, redundant connectivity (resulting in loops) is dealt with by pruning the redundancy – exactly what we don't want in high availability situations.

MAC layer. Few of the requirements accommodated by the 802.16-2005 standard are different for emergency services and military.

One MAC layer difference may be worth mentioning: satellite communications. Today, every satellite communications system within the Department of Defense seems to have its own protocols at what we would call layer 2. And almost all were not built as routable networks but have some kind of wrapper (e.g. Channel Access Protocol) custom-built to provide a routable interface. This has resulted in a great deal of custom work to integrate satellite systems into the radio-WAN mold described above ... at taxpayers' expense. The IEEE 802.16 MAC has the potential to provide an open specification replacement. At the current stage of our research here, the one major difference we've identified that must be accommodated is that with geosynchronous satellites, propagation delay is many times longer than frame length. The current upload map approach fails; SS receives it long after it was applicable.

PHY layer. When my thesis students deal with IEEE 802.16 solutions, the requirement of 'more range' inevitably appears. Often the solution of adding more BS to the infrastructure is not a suitable alternative. Many of the solutions are outside the standards purview and properly subject to individual procurement specifications, but several PHY issues are worth mention:

Increasing power is an option for range, especially for the military, as the FCC rules do not apply in the same way. Most US Coast Guard activity happens in harbors or within few miles of the coast; the existing coastal communications system has a specification to reach to 20 miles offshore (and it needs to be point-to-multipoint).

Shifting from point-to-multipoint to point-to-point can, of course, increase range. But it sacrifices the multicast needs in the process.

Physical velocity is higher with some platforms (e.g. aircraft) than the parameters mention. Liaison between ground forces and close air support aircraft and artillery is one of the frequently mentioned areas where IEEE 802.16 equipment could dramatically improve things.

Both the military and emergency services have spectra available to them that are different than commercial. And these agencies are often obliged to not use commercial spectra.

Some agencies, such as National Guard, have need for frequency agility. One day a unit may be working as emergency services response and have need for interoperability with commercial (including unlicensed) services. The next day the unit might be mobilized and need to work in military frequencies.

EMCON is a military acronym standing for emissions control and roughly meaning 'radio silent'. The ability to accommodate one or more silent IEEE 802.16 SS within a network segment would have value. Similarly, there is value, in some situations, to a network that has low probability of intercept capabilities

beyond the existing lowest usable power algorithm.

If a ship has an IEEE 802.16 BS located on it and the ship rolls, it may disrupt one or more links to SS. Ship rolls are of the order of several seconds. When this happens, the default behavior appears to be that all of the connections must be reestablished. That is, all SS are dumped back into the maintenance window. The same conditions would be induced by a BS in an aircraft or on a terrestrial vehicle that drives through a tunnel. Some on-the-move continuity would be helpful to network segment stability.

Adaptability

The layered structure of the standard allows adaptation for many different situations beyond those within the consciousness of the existing committee. Nearly all of the above desires, shortcomings, and requirements require only changes within PHY.

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