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CyberGeomatic Intelligence – Historical Framework, Problem Definition and Importance of the Topic

(Or What Can Happen When the Digital Divide Is Finally Breached)

by

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"I invoke the first law of geography: everything is related to everything else, but near things are more related than distant things'' (Tobler 1970)[1]

"The exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities on the Earth. GEOINT consists of imagery, imagery intelligence, and geospatial information."[2]
(NGA Definition of GeoInt) and Title 10 U.S. Code §467

ABSTRACT. Thomas P. M. Barnett has expressed the idea (Barnett, 2004) that the world can be divided into the "Functioning Core" characterized by a free flow of information and e-commerce vs. the "Non-Integrating Gap" that is typified as an area of failed nation-states or nations that host despotic regimes and where the majority of actions using the US military have occurred in the last 20 years. It has been stated that this "digital divide"[3] is one of the most significant issues facing undeveloped regions of the world. Even though the term itself denotes an understanding of being spatial in context, there have been very few efforts to examine the implied geographic assumptions underlying the discussions of the "digital divide."[4] The proposed term "cybergeomatic intelligence" means

"the exploitation and analysis of GeoInt and Cyber data sources to describe, assess, and visually depict geographically referenced activities on the Earth in terms of an "effects based" CyberGeomatic perspective." Thomas 2011.

This definition is not only about the physical mapping the internet. It's about the flow of information across the digital divide, the effects of connective technologies and in the redefinition of geographic terms like "distance" and "neighborhood." It's also about extending the lessons of geography to assist the understanding the effects that increased information and communications technologies (ICTs) are having as they are deployed into "the Gap." It is the contention of this paper that a better understanding of the effects and potentials of these technologies with a Cybergeomatic perspective will help alleviate what has been characterized as intelligence "blind spots." This paper looks at the connections between such topics as the digital divide, information theory as proposed by Claude Shannon, a connectivity and information flow model proposed by Dr. Thomas P. M. Barnett, and extends the discussion of the Map Communication Model (MCM) proposed in the 20th century to the concepts proposed by critical cartography and its implications in social media for the intelligence community at large.

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[1] Miller, Harvey J. (2004) Tobler's First Law and Spatial Analysis Annals of the Association of American Geographers, 94(2), 2004, pp. 284–289.
[2] "Brief to NDIA:NGA Office of the Chief Information Officer", downloaded from http://www.ndia.org/Divisions/Divisions/C4ISR/Documents/Breakfast%20Presentations/NDIA_PaulM_Final.pdf
[3] The term "digital divide" was first coined in "Falling Through the Net," a 1998 Commerce Department study, to describe the gaps in computer ownership and usage and Internet usage among various racial/ethnic/income groups. From http://www.hfienberg.com/clips/digitaldivide.htm accessed on 5Oct2011. The original usage is broadened here to encompass the differences between the developed and developing world as characterized by Barnett.
[4] Although there is no definite geographic assumptions there are statistics available of sheer numbers of users by nationality are estimated. Things such as growth rate in developed vs. developing markets also must be considered. From http://blog.euromonitor.com/2011/02/global-digital-divide-persists-but-is-narrowing-1.html accessed on 8Oct2011,

The Environment. Since ancient times, people have used maps to represent real places in space. This allowed them to visualize and think about the presented places while not actually being physically present within that space. Information becomes displayed at a reduced scale organized by a cartographer and expresses a view of extensive regions impossible to see from a single vantage point and communicate information about the represented space to another human being. A dichotomy was identified in the 20th century with respect to such vantage points and access to them. Over forty years ago, Hans Singer (1970) highlighted the technological divide between rich and poor countries, and the term "New World Information Order" was used by UNESCO to describe the disparate flows of information and lack of Information Communication Technology (ICT) infrastructure in parts of the world (UNESCO, 1978). Manuel Castells (1998) has similarly argued that the information age has further exacerbated the social rifts among the classes with the result being the creations of "dual cities" – a two tiered society where the residents have access to different sets of knowledge and experiences.

These dichotomous areas roughly correlate with the areas characterized by Thomas M. P. Barnett as the "non-integrated Gap" and the "functioning Core" in his 2004 book, *"The Pentagon's New Map"* (see Figure 1). As far back as the 1980's it was recognized in the IS field that connectivity and its impacts were on the increase.

> *Today in western societies more people are employed collecting, handling and distributing information than in any other occupation. Millions of computers inhabit the earth and many millions of miles of optical fiber, wire and airwaves link people, their computers and the vast array of information handling devices together. Our society is truly an information society, our time an Information Age.*[5]

[5] Richard O. Mason, "Four Ethical Issues of the Information Age," *Management Information Systems Quarterly*, Volume 10, Number 1, March, 1986, available online at http://www.misq.org/archivist/vol/no10/issue1/vol10no1mason.html . The four issues he identified in 1986 concerned privacy, accuracy, property rights over intellectual artifacts and accessibility.

Countries that are "connected" are counted in region of the "core" and are contrasted with a partial list of places in the "gap" where US forces have been involved in major actions (named operations) the last 20+ years[6]:

1990 – Liberia.
1991 – Persian Gulf War.
1991–96 – Iraq. Operation Provide Comfort.
1992 – Sierra Leone. Operation Silver Anvil.
1992–96 – Bosnia and Herzegovina. Operation Provide Promise
1992–2003 – Iraq. Iraqi No-Fly Zones
1992–95 – Somalia. Operation Restore Hope.
1993 – Macedonia.
1994–95 – Haiti. Operation Uphold Democracy.
1995 – Bosnia. Operation Deliberate Force.
1996 – Liberia. Operation Assured Response.
1996 – Central African Republic. Operation Quick Response.
1997 – Albania. Operation Silver Wake.
1998 – Iraq. Operation Desert Fox.
1998 – Guinea-Bissau. Operation Shepherd Venture.
1998 – Afghanistan and Sudan. Operation Infinite Reach.
1999 – Serbia. Operation Allied Force.
2001 – War in Afghanistan
2003–2010 – War in Iraq
2004 – War on Terrorism: US anti-terror related activities underway in Georgia, Djibouti, Kenya, Ethiopia, Yemen, Pakistan Uganda, Mali, Mauritania and Eritrea etc.

[6] This list is far from complete. http://en.wikipedia.org/wiki/Timeline_of_United_States_military_operations

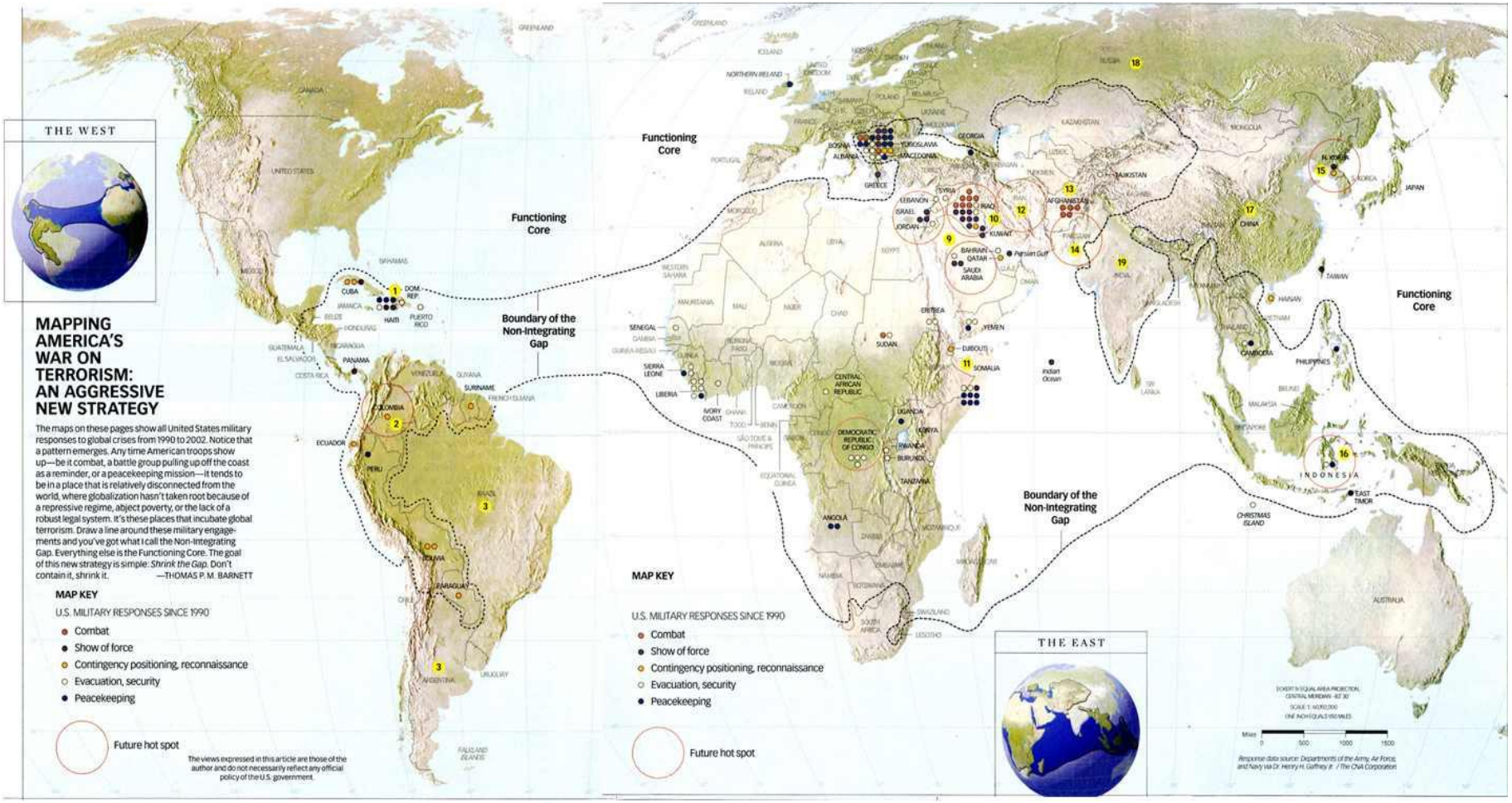

Figure 1. Thomas P.M. Barnett's original characterization of the Pentagon's New Atlas. This division between the connected and non-connected areas of the globe drew the association between the lack free flow of knowledge and the areas where US military forces were most likely to be engaged. The author's premise is that the more "connected" the less likelihood of a need for military intervention by the US military.

The proliferation of Geospatial Information Systems (GIS) technologies in the last decade has maintained a pattern of growth even in slow economic times[7]. This is due in large part to the investments made by the Department of Defense (DOD), the Department of Homeland Security (DHS) and the rest of the public sector. This large investment in GIS and accompanying growth in the IT sector in general has led to a conflation of new technologies that service the intelligence community and contribute to new methods of evaluating collected information[8] – both open source and classified. This in turn has led to a new way of evaluating intelligence and the growth in demand and abilities of analysts who think geospatially when performing traditional intelligence analytic tasks.

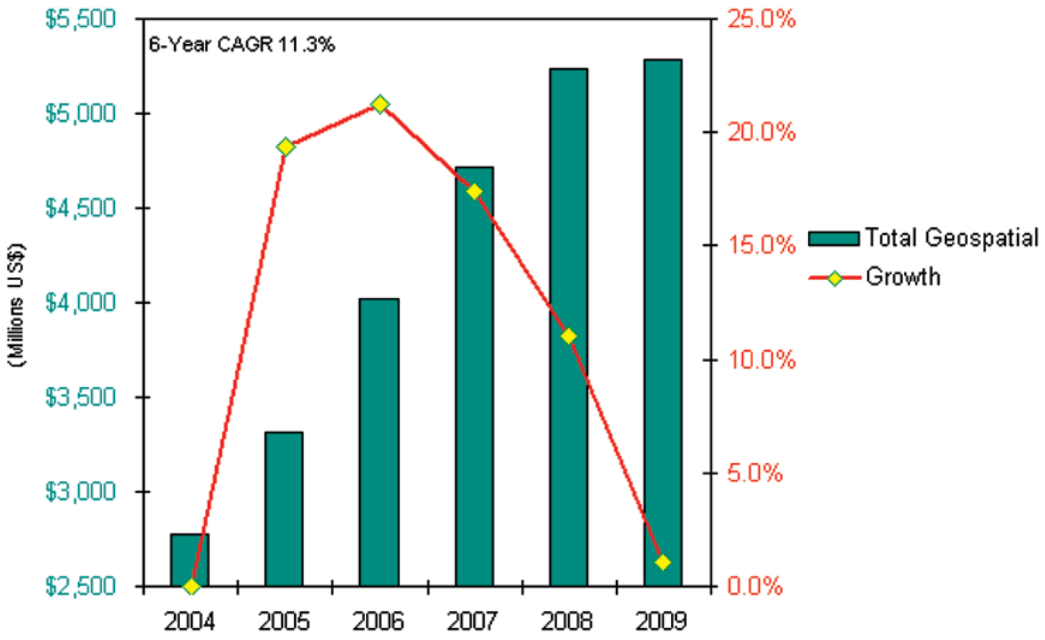

Figure 2. GIS/geospatial industry growth, 2004-2009: Total (software, services, hardware, data) worldwide revenue estimates and forecast. Accessed from http://www.webmazine.org/issues/bull242/documents/GISindustryForecast.pdf on16Oct2011.

[7] According to Charles Foundyller. Accessed on 15Oct2011 from the online journal of the American Congress on Mapping and Surveying http://www.webmazine.org/issues/bull242/documents/GISindustryForecast.pdf

[8] According to the Committee on Beyond Mapping: The Challenges of New Technologies in the Geographic Information Sciences, downloaded from the National Academy of Sciences, 2006, from http://www.nap.edu/catalog.php?record_id=11687 on 15Oct2011.

Attempts to visualize the relationships between various fields of knowledge have led to complex diagrams that attempt to relate everything[9] (see Figure 3a and 3b) with no geographic reference to ones that focus on the field of Geomatics only[10] (see Figure 4) with a clear geospatial reference. Others have focused on visualizations of where explicit (as differentiated from tacit) knowledge is located and where it is produced – a focus on visualization that relies on a well-defined geospatial reference[11] (see Figure 5).

A difficulty arises from attempting to translate non-spatial attributes and provide them with a spatial reference in an information architecture not equipped for them but where they are both meaningful and fall into the span of the information space[12]. This struggle is currently somewhat paralleled in the US governments attempts to define cyberspace as an operating domain discrete and separate from the accepted and understood domains of sea, land and space. Furthermore, most intelligence activities in cyberspace are currently directed towards ideas centered around the physical connective layers, their operations and their defense.[13] This layer provides the infrastructure for CyberGeomatic Intelligence but is not itself the domain. There is a

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[9] The Map of Science was a result. *"By crunching data from more than a billion user interactions on scholarly databases, Los Alamos National Laboratory researchers produced a high-resolution map of the relationships between different fields of science."* Accessed from http://www.plosone.org/article/info:doi/10.1371/journal.pone.0004803 on 15Oct2011.

[10] This refers to the diagram of the three subdomains comprising the GI S&T domain, in relation to allied fields. Two-way relations that are half-dashed represent asymmetrical contributions between allied fields. The image shows innovations pushing society beyond mapping into a far more versatile and powerful vision of mapping that draws on many additional sciences and technologies.

[11] This has been attempted by staff at the Oxford Information Institute in *"Geographies of the World's Knowledge."* Accessed from http://www.oii.ox.ac.uk/publications/convoco_geographies_en.pdf on 8Oct2011.

[12] Specifically, "human terrain" efforts have favored large, complex technical acquisition programs that show little appreciation of where the lion's share of human dynamics expertise actually resides, how human dynamics differ by geography, or how today's human dynamics have been shaped by the past. From http://www.geospatial-intelligence-forum.com/mgt-home/239-gif-2010-volume-8-issue-3-april/2756-rethinking-human-dynamics.html accessed on 15Oct2011.

[13] As documented in the recently released "Cyber intelligence:Setting the Landscape For an Emerging Discipline," downloaded from https://images.magnetmail.net/images/clients/INSA/attach/INSA_CYBER_INTELLIGENCE_2011.pdf on 31Oct2011. While the document leans forward to point out that some of the civilian infrastructure needs to fall under the DoD AOR, it falls short in not speaking to collection priorities that exist in this new domain.

difference between what is being referred to as Cyber Intelligence and CyberGeomatic Intelligence. While "CyberInt" concerns itself more with the connectivity, the infrastructure and defense of the grid, it does not take into account the geospatial aspects of the intelligence and the deeper context such aspects provide. The Army's *"Human Terrain System"* attempted to provide cultural and social science insight to field commanders but was limited by the requirement for embedding specialists with deployed forces and using narrowly-defined data sources due to sampling techniques (Hamilton, 2011). The effort focused on scientifically defendable and repeatable approaches and meta-data decisions. Without addressing higher level requirements tasks, the analytic products produced provided only specific answers to the questions of a single non-expert customer. In their closing remarks in *"Fixing Intel: A Blueprint for Making Intelligence Relevant in Afghanistan,"* MG Flynn and Capt. Pottinger point out the potentials for accessing and using the social networks as a means of marginalizing the insurgents using IEDs. The potential was recognized but was beyond the scope of their analysis at the time.

The Technology. The cumulative advances in not only in new technologies but in new operating domains has produced a creative tension in the mapping and information science fields analogous to the one earlier identified by the Committee on Beyond Mapping in 1991[14]. The need for new metaphors (or new conceptualizations) was identified as far back as 2001[15] by Sui and Goodchild, in their paper *"GIS as Media?"*

> *"Media are generally understood as means of sending messages or communicating information to the general public, and mass media are the instruments by which mass communication takes place in modern societies. Mass media are also the most effective means of broadcasting information to large numbers of people in a short period of time."*

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[14] *"Profound structural changes were underway not only in the agencies primarily concerned with the production of maps but also among the country's academic disciplines. Programs were being reorganized to recognize both the new skills needed by mapping scientists and the new commonalities between them."* Pg 88 from http://www.nap.edu/catalog.php?record_id=11687.

[15] *"GIS as Media,"* was written at a time when the technologies of Social Media were still in their infancy and were not yet linked to a geospatial capability.

In reality the issues go beyond the traditional one way communication characterized as traditional media. A functioning GIS is not simply a repository of knowledge "broadcast" by a cartographer. Geomatics as empowered by social media technologies adds the capability of real time interaction that provides a heightened sense of awareness that can empower a group to plan, coordinate and react to a situation occurring on the ground in real space, real time. It is becoming apparent to many inside and outside the DOD that events such as the Arab Spring can be planned on Facebook, implemented and controlled via Twitter, broadcast to the world via You Tube[16] and mapped and displayed in real time via Ushahidi[17].

A stated goal of GIS[18] is to communicate information to a larger audience in society and social media has certainly provided a means of doing this. With the Arab revolts across the Maghreb in the last year, the instantiation of both digital places and digital individuals (Curry 1998), is providing us *"not only Arnold Toynbee's etherization of history but also the etherization of geography"*[19]. As in 1991, when the term Geomatics was proposed as an attempt to rename certain components in the mapping arena (see Figure 5), the term CyberGeomatic Intelligence needs to be adopted as a broadening of thought brought about by the proliferation of the new technologies and their impact on cartographic thought with respect to intelligence collections. The proposed term "cyberspatial intelligence" or "CyberGeomatic Intelligence" means *"the exploitation and analysis of GeoInt and Cyber data sources to describe, assess, and*

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[16] As documented in a briefing held by NATO officials at the Social Media in Comprehensive Approach Workshop Presentations , 12 - 13 October 2011, in Utrecht, Netherlands. Presentation downloaded on 31Oct2011, from http://www.c2coe.org/ppt/Workshop/8%20-%20Syndicate%20B%20Social%20Media%20in%20the%20military.ppt slide 11.

[17] Ushaihidi has been used in both regional revolts in the Mahgreb, but also for natural disasters across the globe. For more details see http://ushahidi.com . Similar to Twitter and Facebook, Crowdmaps rely on user-generated videos, images, and reports; the difference is that information is verified and geo-plotted on online maps, usually by nonprofits or a trusted network of local citizens.

[18] Ibid.

[19] Ibid.

visually depict geographically referenced activities on the Earth in terms of an "effects based" CyberGeomatic perspective". It's not about mapping the internet. It's about the flow of information, the effects of the connective technologies and the redefinition of geographic terms like "distance" and "neighborhood" terms that have historically been referenced in terms of Euclidean space and which now should be redefined to recognize effects in Euclidean space from non-Euclidean origins made possible by Information Communication Technologies (ICT).

Before the start of the Global War on Terror in 2001, the intelligence processes and tools used by the US government were mostly directed at traditional Cold War threats with well understood functions and activities. With the rise of importance of non-state actors and asymmetric threats, threat-focused processes and tools are now directed at known threats whose functions and activities are not well understood (Baird, 2002). The intelligence environment in 2012 is characterized by data overload, with the information age exponentially increasing the volume, variety, and velocity of available data (George and Bruce 2008).

A new intelligence discipline must apply sources, sensors, and analysis to provide an opportunity to create a decision advantage by a policy maker. The current 'int' disciplines each arose out of a change in environment and technology that required a concurrent change to provide a new and unique perspective on the new threat (Finley, 1995). As with the tale of seven blind men examining an elephant, each is focused on a feature of the elephant, not on a relationship between the features. When combined by a talented analyst, the relationships between the features can provide a more total picture. The current recognized intelligence disciplines include Open-Source (OSINT), Human (HUMINT), Signals (SIGINT), Geographic (GEOINT), Measurements (MASINT), Technical (TECHINT), and Counter Intelligence (CI) (CJCS, 2007). They all individually require specialized requirements officers, collectors and

analysts with unique skillsets. They all rely on network analysis tools to add value to analytical products and enhance an analyst's ability to spot non-obvious linkages. However, CyberGeomatic Intelligence is a unique discipline, not a tool set. CYBERGEOINT can provide insights into relationships to build a representation of threats and describe the behavior of a system of systems with a geospatial reference. This proposed new methodology can provide both a decision advantage with new insights and enhance decision confidence through adapting repeatable quantitative processes. Data sources include inputs from other "ints" as well as a ubiquitous computing environment, geospatial analytic software and social media. The unique perspective can produce population indexing, sentiment analysis, and models of human intent (Howard and Guidere, 2011; Blair-Goldensohn, S. et al, 2010) with the goal of enhanced geospatially based situation awareness.

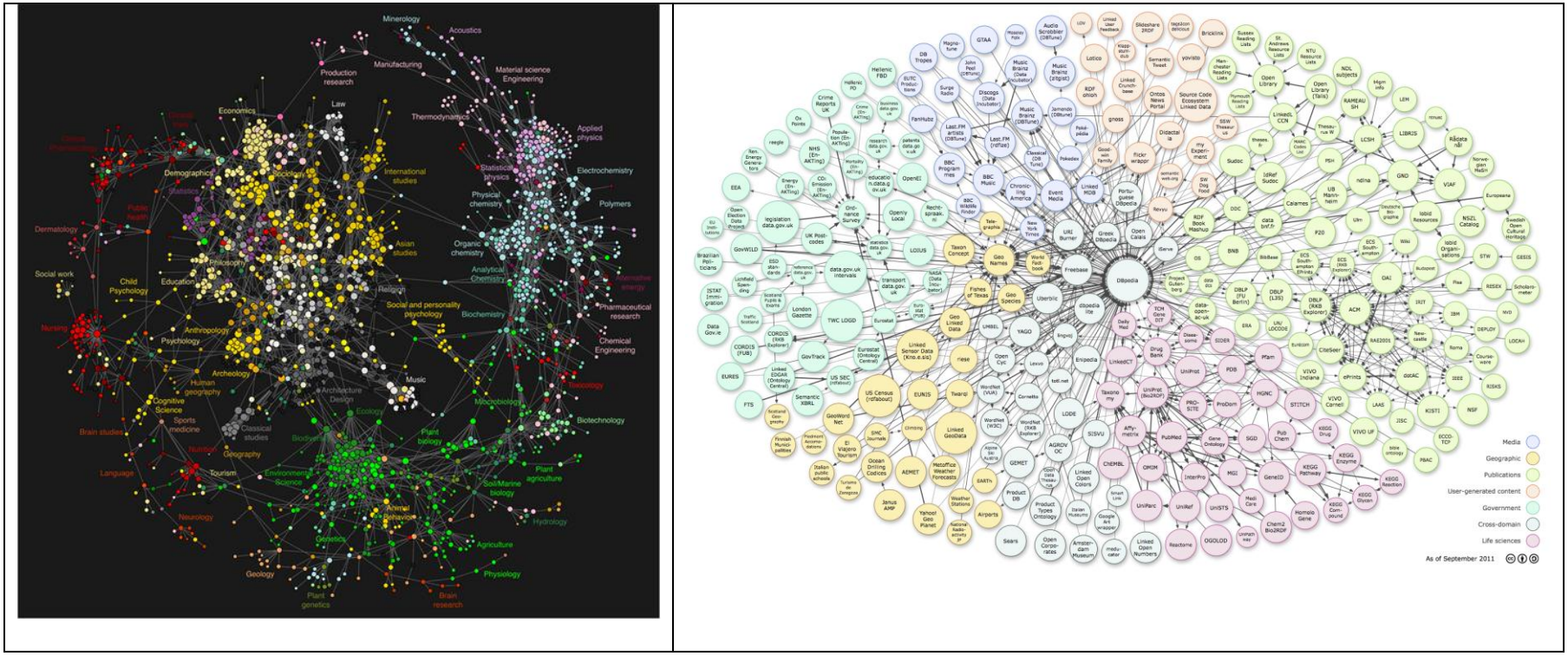

Figure 3a. (Left) The Map of Science as compiled by researches at Los Alamos National Labs. This is a visualization of over 1 billion citations from scientific journals collected over 2006-2007 and displayed according to connections by discipline. A further discussion of the methodology and categorization is discussed at http://www.plosone.org/article/info:doi/10.1371/journal.pone.0004803. Fig 3b. (Right) The database of databases compiled in the linked data project with the goal to have all databases everywhere linked and accessible in real time. Downloaded from http://richard.cyganiak.de/2007/10/lod. Linking Open Data[20] cloud diagram, by Richard Cyganiak and Anja Jentzsch. http://lod-cloud.net

[20] This image shows datasets that have been published in Linked Data format, by contributors to the Linking Open Data (LOD) community project and other individuals and organizations. It is based on metadata collected and curated by contributors to the CKAN directory. After going to the webpage, clicking the image will take you to an image map, where each dataset is a hyperlink to its homepage.

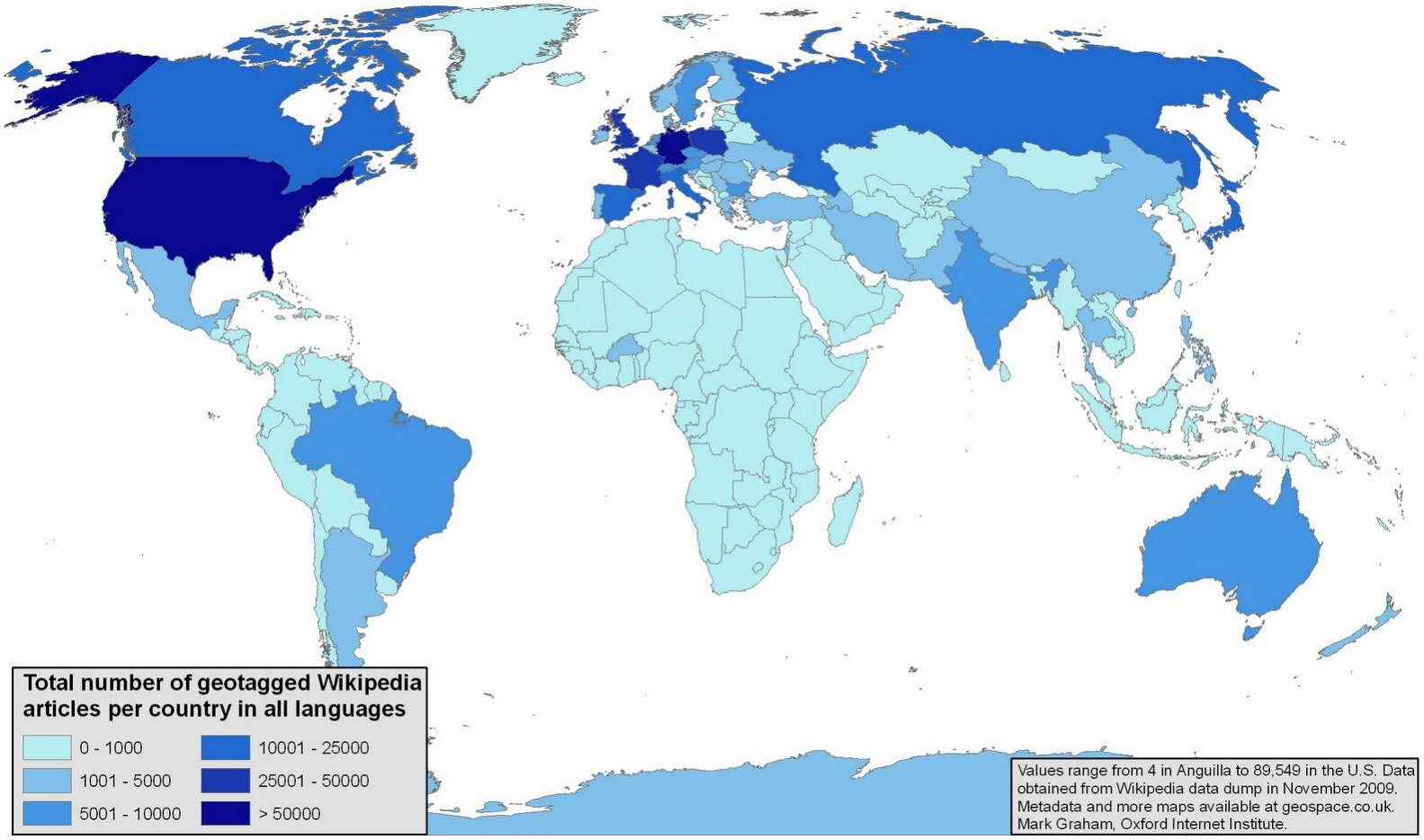

Figure 4. Items geotagged in Wikipedia in all languages. When comparing this map with Figure 1, one could draw the conclusion that not only is the information existent in the Functioning Core, but information seems to beget information. The New York Times Idea of the Day in December 2009, pointed out that more Wikipedia articles are written about fictional places like Middle Earth than about many countries in Africa, the Americas and Asia. Behold the "terra incognita" of the Internet. Accessed from http://www.oii.ox.ac.uk/publications/convoco_geographies_en.pdf on 8Oct2011.

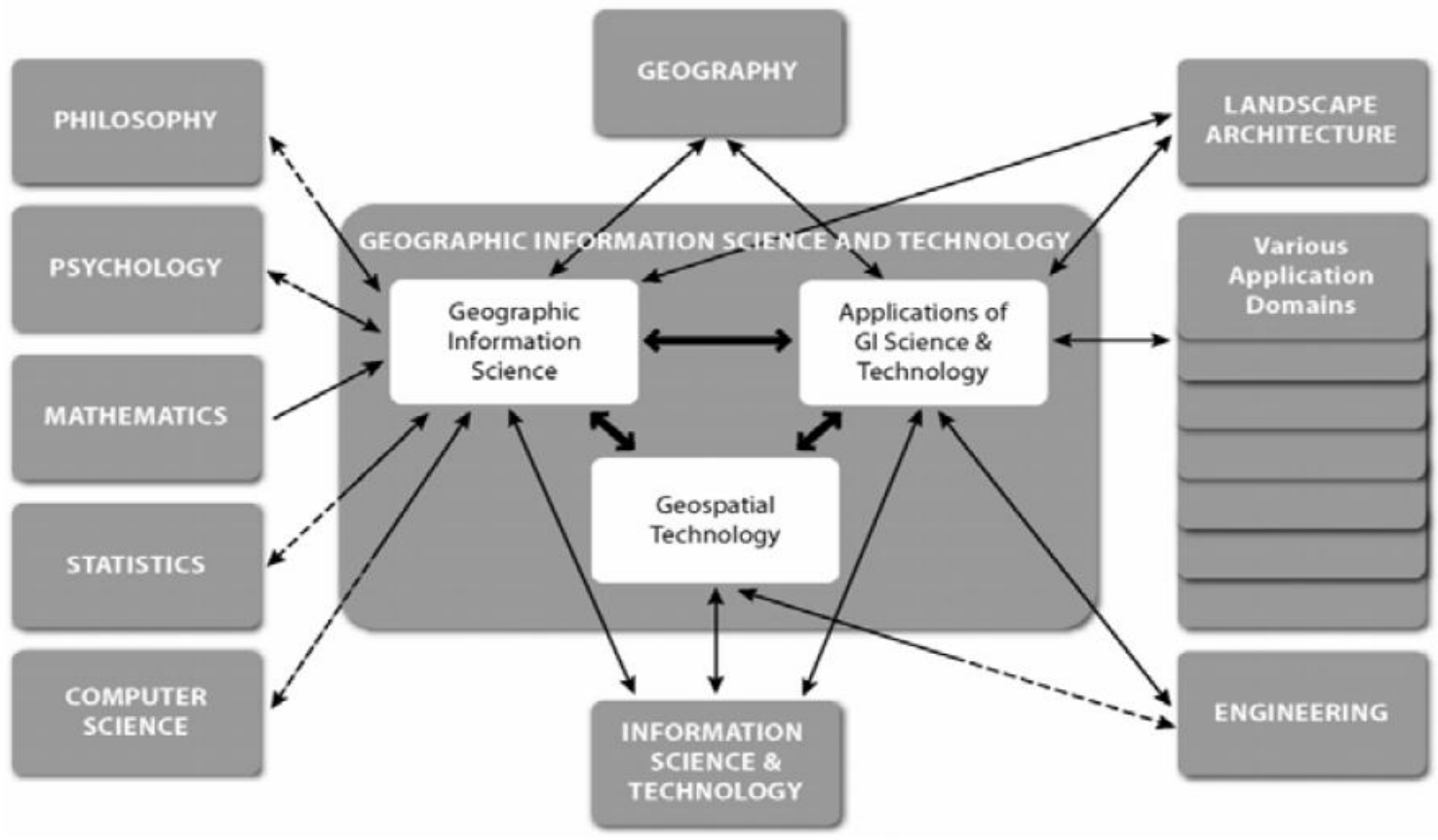

Figure 5. The three subdomains comprising the GI S&T domain, in relation to allied fields. Two-way relations that are half-dashed represent asymmetrical contributions between allied fields. The image shows innovations pushing society beyond mapping into a far more versatile and powerful vision of mapping that draws on many additional sciences and technologies. Source DiBiase, D., M. DeMers, A. Johnson, K. Kemp, A. Luck, B. Plewe, and E. Wentz, eds. (2006).

Sui and Goodchild provide an excellent discussion[21] regarding the association of cartography with communication theory as proposed by Claude Shannon. They speak of the emphasis of this idea in the literature in the 1970's and 80's that led to the proposal of the Map Communication Model (MCM) endorsed by Alan MacEachren in his 1995 book, *"How Maps Work,"* but later dismissed by him as being incomplete since it only provided a 1-way method of communicating information from the cartographer to the end-user.[22] Further research, perhaps as a result of the proliferation of ICTs, has begun to define the ability of two way interactions that replaces the MCM idea of the cartographer being the lone disseminator of geospatially oriented knowledge to a user, to the idea of critical cartography that links cartography to power and as such gives it a political context as well. The development of the 2-way geo-referenced communication architecture enabled in Web 2.0 technologies in turn places maps in the realms of power brokering and elevates them from being neutral scientific documents. One idea in critical cartography expresses that *"maps are active, they actively construct knowledge, they exercise power and they can be a powerful means of promoting social change."*[23] The knowledge of cartographic visualization coupled to the technology of 2-way enabled ICTs has certainly made this case in the last year. In fact, the events in the Arab Spring seem to be a case study to this effect. This set of spatial relationships must speak to a point of origin and a point of effect where a set of coordinates defines and establishes the connection and relationship between any number of "n" points. Rather than an ordered triple of (x, y, z) located somewhere on a sphere, it in effect can be described as an ordered septuple of (x_1, y_1, z_1, x_2, y_2, z_2, t) where the

[21] Ibid.
[22] There is an excellent discussion of this shortfall and evolution at http://ubikcan.blogspot.com/2006/08/map-communication-model-and-critical.html that discusses the evolution from the MCM construct to a theory now called Critical Cartography. The main point of the discussion emphasizes the map is conceptualized as a communicator of knowledge – knowledge being information containing a cultural context that also allows for more than 1-way communication.
[23] Ibid.

first ordered triple represents the point of origin, the second ordered triple the point of effect and the 7th component is a shared temporal component that defines when the ICT derived association is made from one place to another in near real time (see Figure 6).

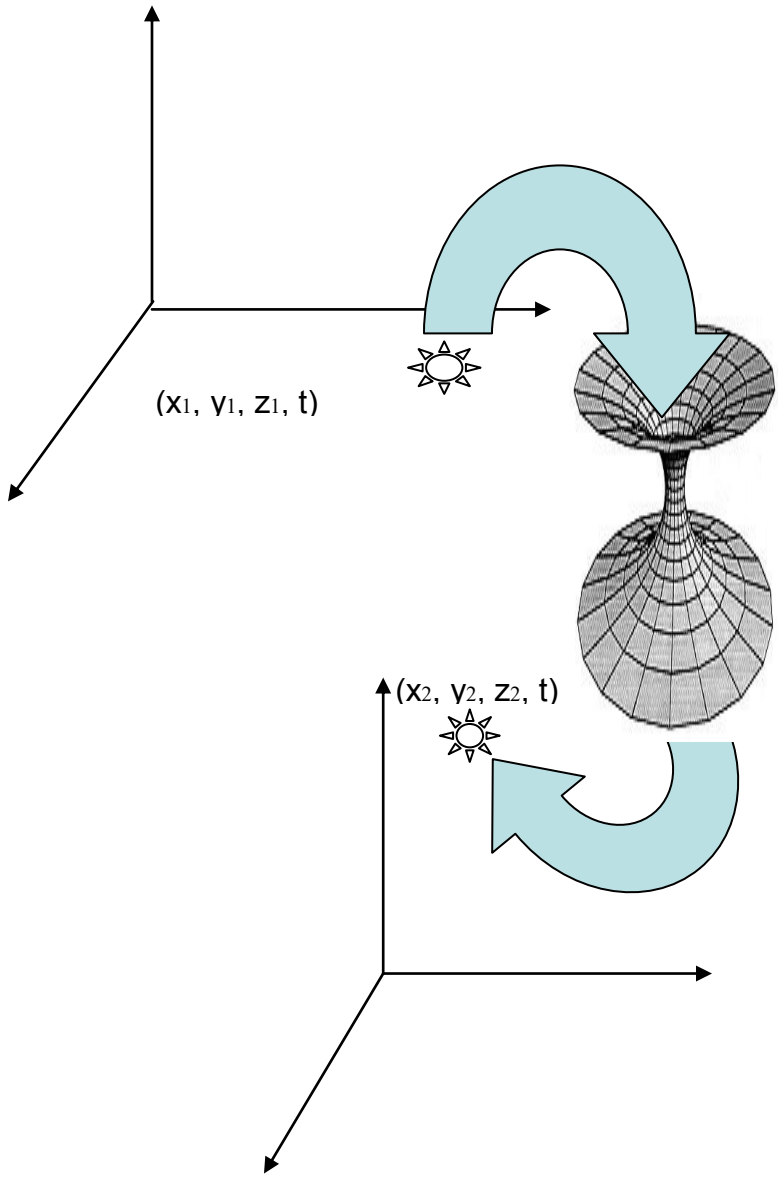

Figure 6. Visualization of an information effect initiated at one point on earth identified by an ordered triple having an effect on another point on earth. The ordered septuple (X_1, Y_1, Z_1, X_2, Y_2, Z_2, t) defines the point of origin and the point of effect which share both a common geographic reference and a common time t. ICT enables the connection and makes them in the same information neighborhood. Events in one part of the world can have vast consequences in others. The uprising that began in Tunisia sparking calls for change across the Middle East or a Koran burning in the US leading to the killing of UN workers in Afghanistan are recent examples. Original graphic by M. Thomas, 2011.

In his 1996 paper, *"The Physical Nature of Information,"* Rolf Landauer proved mathematically that information cannot exist without physical infrastructure, from being a chink in a stone tablet, a hole in a computer punch card or even a subatomic particle with spin either described as up or down.

> *"Information is inevitably tied to a physical representation and therefore to restrictions and possibilities related to the laws of physics and the parts available in the universe. This ties the handling of information to all the possibilities and restrictions of our real physical word, its laws of physics and its storehouse of available parts."*

The parts Landauer was most concerned with were the physical computers of IBM, where he was employed as a senior researcher when he wrote this paper, and he showed mathematically that there was entropy associated with the computation of information. The Landauer Principal states that, *"any logically irreversible manipulation of information, such as the erasure of a bit or the merging of two computation paths, must be accompanied by a corresponding entropy increase in non-information bearing degrees of freedom of the information processing apparatus or its environment".* (Bennett, 2003). The Landauer Principle, also known as the Landauer Limit, was first suggested by von Neumann in 1949 but waited to be proven mathematically by Landauer and Bennett later.

The internet and hence cyberspace are both grounded by supporting infrastructure and so cyberspace can only exist in particular geographic spaces where that supporting infrastructure is in place. Places exist and become relational across distance because of connectivity through cyberspace. This defines links between real places and places in cyberspace that are *"articulated moments in networks of social relations and understandings rather than areas with boundaries."*[24] Figure 6 invokes the visualization of information flow from one set of coordinates to another (and back again) through a cyberspace "wormhole." The wormhole analogy provides a

[24] Essentially, geography has always been relational, and technology can only supplement place-based references and does not replace it. The effects of spatial autocorrelation can be extended to distant locations because of advanced ICTs.

convenient method to conceptualize the methods that networks use that make them geographically consistent and specific yet still acquire access to distant points and have an effect between distant points once the information has been exchanged. It does not break Tobler's first law of geography – technology merely extends the effects of the definition. For example, the "Green Zone" in Baghdad has more in common with Langley, Virginia, than with other places in Iraq immediately outside its walls. Extending, or applying Landauer's principle to geospatial information in cyberspace inevitably leads to the realization that there is a geospatial component *about* cyberspace. Cyberspace is real and has physical "location" associated with it and the information that passes through it and this is the extension of Tobler's first law of geography mentioned earlier. Increases in infrastructure have the effect of minimization of the digital divide. It leads to increases in the places where Cyberspace can exist and an accompanying increase in the relational aspects between distant places.

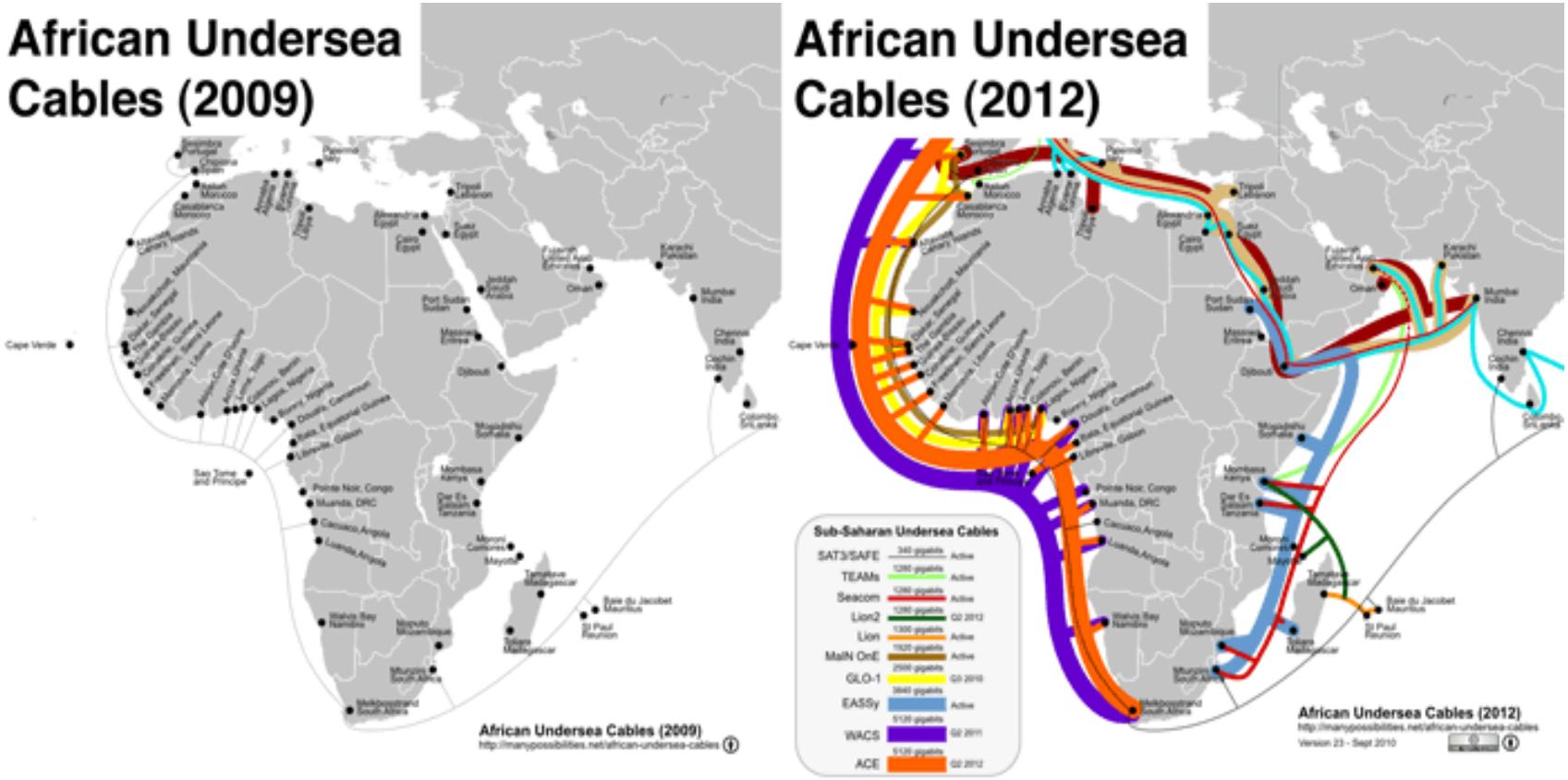

Figure 7. Low-cost, abundant, easily distributed information lowers transaction costs, which affects the nature of institutions and organizations. When internet connectivity was mostly carried on satellites it (and the transaction costs) were high. As these cables come online, more and more the transactions costs are going to come down. Infrastructure increases in Africa will eventually lead to increases in information flow, and associated increases in relational aspects between distant points. What could formerly be characterized as "Terra Incognita" is changing with increases in infrastructure. Downloaded from http://www.oii.ox.ac.uk/research/projects/?id=59 . Would the "Arab Spring" have been possible in 2009? The lack of infrastructure makes it doubtful. Once all the cables are in place Africa's total bandwidth will increase from 6 terabytes/second (tbps) to as much as 34tbps. Currently there are over half a billion Africans connected to the global system through cell phones and Internet and this number will increase.

The Arab Spring, Iran and the LRA – Case Studies From "The Gap". While the capabilities and potentials of advanced ICTs are all fairly obvious, the incorrect assumption that the "Functioning Core" is monolithic and uniform with respect to information availability and access would be misleading not to address. Many governments across the planet take serious steps to attempt to limit access of their citizenry to modern ICTs. Far from being either "the death of distance" (Cairncross) or the "end of geography" (O'Brien), the implementations of modern and proposed ICTs have contributed to a series of disruptive effects on North Africa and will by extension have such effects in sub-Saharan Africa and other parts of the globe as new infrastructure is established. Democracy might be a result – or it might not. While ICTs conceivably have had effects on the events of the Arab Spring, this does not by extension make them more democratic in their effects when it comes to governing – this will remain to be seen for some time. Digital tools may make it easy to destabilize governments – this does not mean it will make it easier to enable new ones. The capability associated with the implementations of the new ICTs creates a degree of angst among some in the DoD.

> *"Having a real time map complete with satellite photos, of where everyone is at any one moment is almost as good as having your own helicopter overhead - maybe better, if you can distract the crew of the helicopter."*[25]

The Arab Spring was planned on Facebook, managed on Twitter and executed via Twitter and SMS texts. How many more are out there waiting to happen? How does the IC "dial in," monitor and exploit these potential humint sources? Even the recent Kenyan military

[25] This was quoted in a lecture by Patrick Meier of Ushahidi . Available at http://www.youtube.com/watch?v=Hh_PiVqf8BA at 31:42 into the talk.

intervention into Somalia made use of Twitter as a means of broadcasting warnings to non-combatants.[26]

Interest in the potential of using sources of information as *collection sources* has not escaped the notice of the intelligence community. A competition is currently underway between various academic teams whose goal is to see if forecasting as performed by crowds can provide better insights into world events over a range of topics from disease outbreaks to political patterns.[27] There are multiple approaches being applied but at stake is millions of dollars in research money from the Intelligence Advanced Research Projects Activity (IARPA) which is part of the Office of the Director of National Intelligence (ODNI). Professors Charles Twardy and Kathryn Laskey have assembled such a team at George Mason University as documented recently in the press.[28] Their goal is to establish a baseline of data to measure exactly how accurately a crowd of subject matter experts might be able to gauge situations potentials in security issues using a phenomenon known as the "wisdom of crowds."

On 4Nov2011, the Washington Post reported that there was a group of analysts at the CIA known as the "vengeful librarians" whose open source mission is to monitor and analyze reportedly up to 5 million tweets a day in multiple languages. The agency's Open Source Center

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[26] As reported on 2Nov2011 at http://www.capitalfm.co.ke/news/2011/11/kenya-warns-targeted-somalia-towns-on-twitter .

[27] Applied Research Associates, a New Mexico-based firm, has launched a program it hopes will improve upon the traditional methods of gathering expert opinion by using computer software that could make better-informed predictions. The system chooses the best sources of information from a huge pool of participants. The firm's southeast division, headquartered in Raleigh, N.C., has teamed with seven universities to devise a method of farming out global intelligence questions to the general public through the Internet. It began collecting crowdsourced opinions in early July. Crowdsourcing is a method of problem solving where a task is doled out to an undefined group of people through an open call to participate. As reported at http://www.nationaldefensemagazine.org/archive/2011/December/Pages/USGovernmentTurnstoCrowdsourcingforIntelligence.aspx?PF=1

[28] This story was reported the week of 21Oct2011, at http://www.nj.com/news/index.ssf/2011/10/university_studies_crowdsourci.html and at http://www.overcomingbias.com/2011/08/join-gmus-daggre-team.html but only the efforts of George Mason were identified by name.

was established as a recommendation of the 9/11 commission and maintains scrutiny on both social media sources and others in their native languages.[29] What type of geospatially oriented information can be gleaned from such sources? A developer at ONSTAR named Virender Ajmani runs the blog called http://www.mibazaar.com/meprotests.html that has been frequently mentioned in different news stories[30] One site in particular monitors real time tweets from various Arab countries as seen in Figure 8. Topics as diverse as advertising to political statements can be viewed in near real time, collected and mapped for patterns.

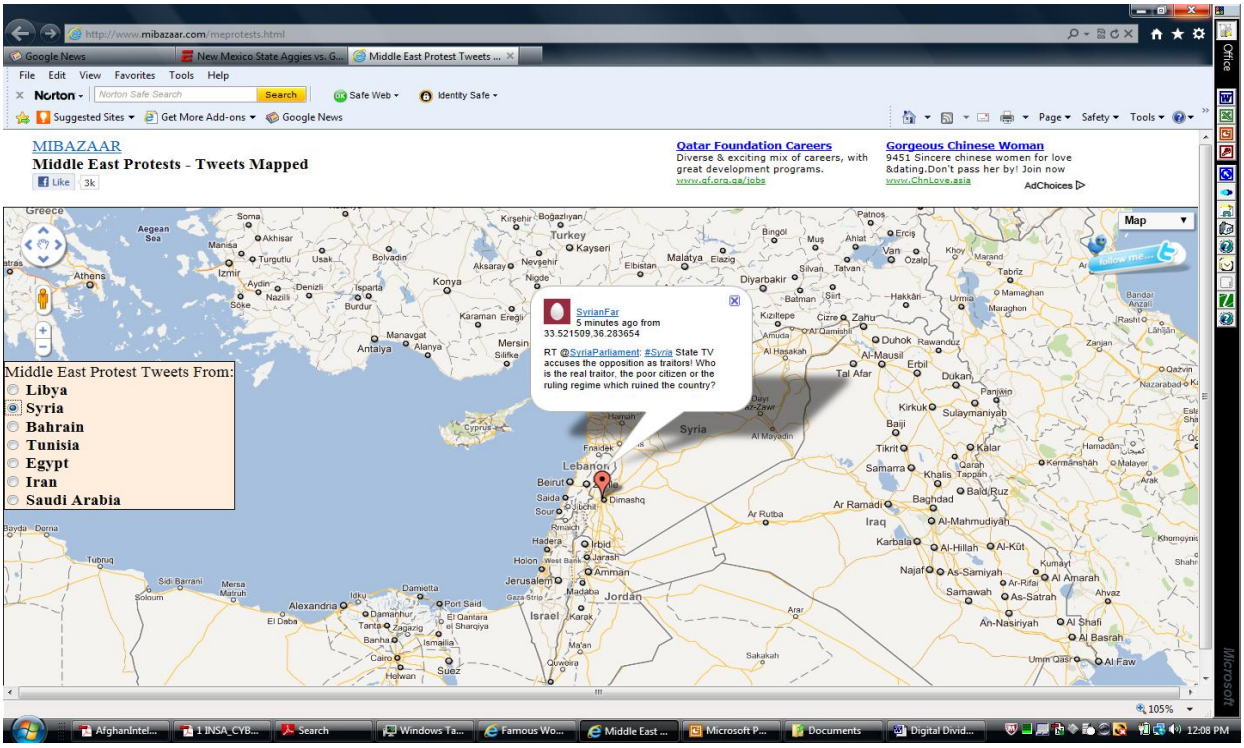

Figure 8. *"State TV accuses the opposition as traitors! Who is the real traitor, the poor citizen or the ruling regime which ruined the country?"* is an example of a political commentary made presumably by an irritated Syrian civilian in the 120 characters or less available on a Twitter broadcast 5Nov2011. A quick message broadcast over the Web obviously provides a glimpse into the thought of HUMINT sources in country. From http://www.mibazaar.com/meprotests.html

[29] The Associated Press reported that the CIA follows up to 5 million messages on Twitter every day, as well as posts to Facebook, news sites and chat rooms in a constant effort to paint a real-time picture of regions across the globe. Accessed on 5Nov2011 from http://www.washingtonpost.com/national/ap-exclusive-whos-following-you-on-twitter-or-facebook-maybe-cias-vengeful-librarians/2011/11/04/gIQA093zkM_story.html

[30] Access the list of stories at http://sites.google.com/site/mibazaar . One in particular is highlighting "Arab Spring" tweets at http://www.mibazaar.com/meprotests.html .

A series of posts and technologies has occurred in the last few years that have demonstrated the potential of using the outputs of social media technologies as collection sources of intelligence. Kovas Boguta[31] demonstrated the use of a simple monitoring program to provide a visualization of the Egyptian protesters tweets that was concurrent with the ousting of President Hosni Mubarak. He states in his online blog:

> *"Experts say Egypt is the crystal ball in which the Arab world sees its future. Now that Mubarak has stepped down, I can share the work I've done making that metaphor tangible, and visualizing the pro-democracy movement in Egypt and across the Middle East. It is based on their Twitter activity, capturing the freedom of expression and association that is possible in that medium, and which is representative of a new collective consciousness taking form."*

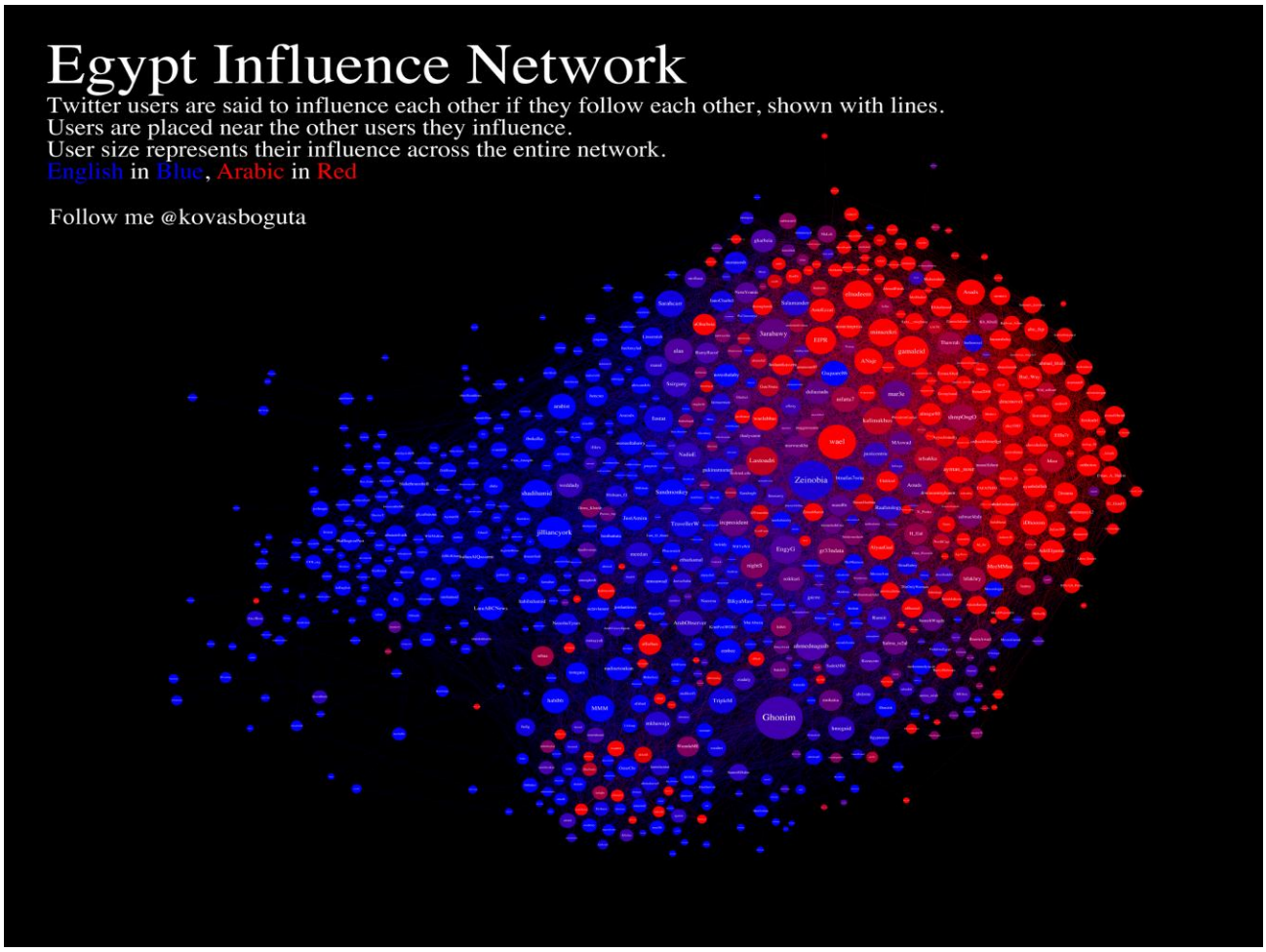

Figure 9. The map is arranged to place individuals near the individuals they influence, and factions near the factions they influence. The color is based on the language they tweet in. The size of the node reflects the individual influence on the entire network.

[31] This is an example of non-georeferenced information concerning an event occurring in a known location. From http://www.kovasboguta.com/1/post/2011/02/first-post.html accessed on 23Oct2011.

If such patterns as seen in Figures 9 can be collected and analyzed in a timely fashion there may be huge potential in the insights that result. While the patterns that emerge in the Egyptian dataset (Figure 9) seem to indicate no particular pattern, when we review the patterns emergent in the Iranian election protests (Figure 10) it is readily apparent that there are key nodes that are communicating and acting as individual nexus' of communications. The potential seems to exist for the exploitation of mapping how ideas form and promulgate across users in physical area, mapping individuals/group opinions as they form and promulgate and perhaps even mapping disaster hot-spots as they occur. Figure 10 provides an example of a pattern that can emerge from a well organized set of tweets.

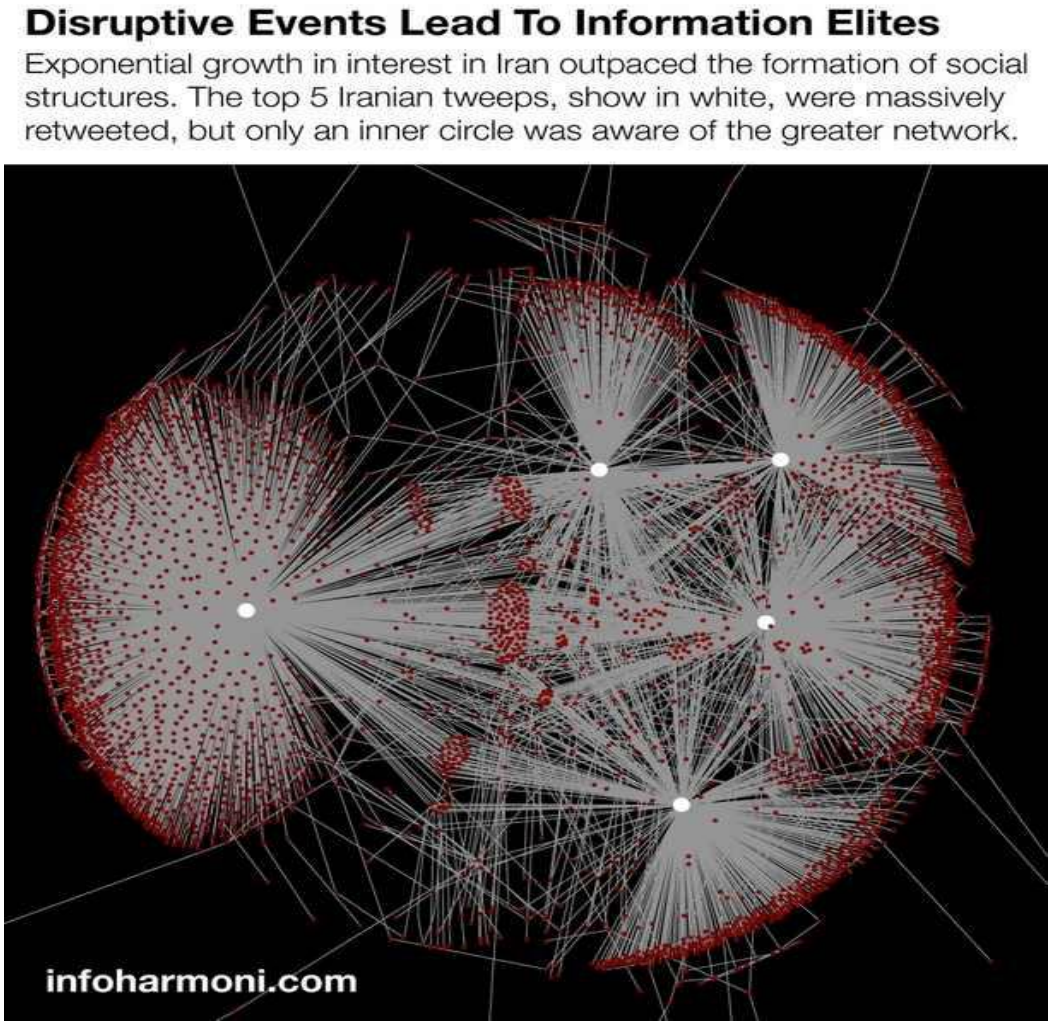

Figure 10. Display of tweets from key persons in the 2009 Iranian election protest[32]. The structure shows the emergence not of a community but of an elite group of leaders. The Iranian intelligence services were interested but most people did not discover more than one of the top Iranians. The network simply grew faster than the information could naturally propagate. One wonders if a six shot revolver could have collapsed the network had the officials identified all 5 organizers. Graphic downloaded from http://www.readwriteweb.com/archives/evolution_revolution_visualizing_millions_iran_tweets.php

While not an inherently spatial visualization, the diagrams of tweets in Figures 9 and 10 nonetheless have a geographic underpinning. The tweets are originating from "somewhere" and are being rebroadcast to "somewhere else." It is not a matter of much conjecture to imagine that the identity of the 5 identified supernodes has intelligence value to the Iranian secret police.

[32] This was also documented by Newsweek Magazine in June 2009. The timeline high points are listed and analyzed at http://www.thedailybeast.com/newsweek/2009/06/25/a-twitter-timeline-of-the-iran-election.html .

Gathering such intelligence, identifying the physical location (as well as the identity) of the persons associated with the nodes would hypothetically prove beneficial to one set of parties and potentially harmful to another. Being able to manipulate the traffic might have similar associations. This is another example of collections of CyberGeomatic Intelligence as defined earlier.

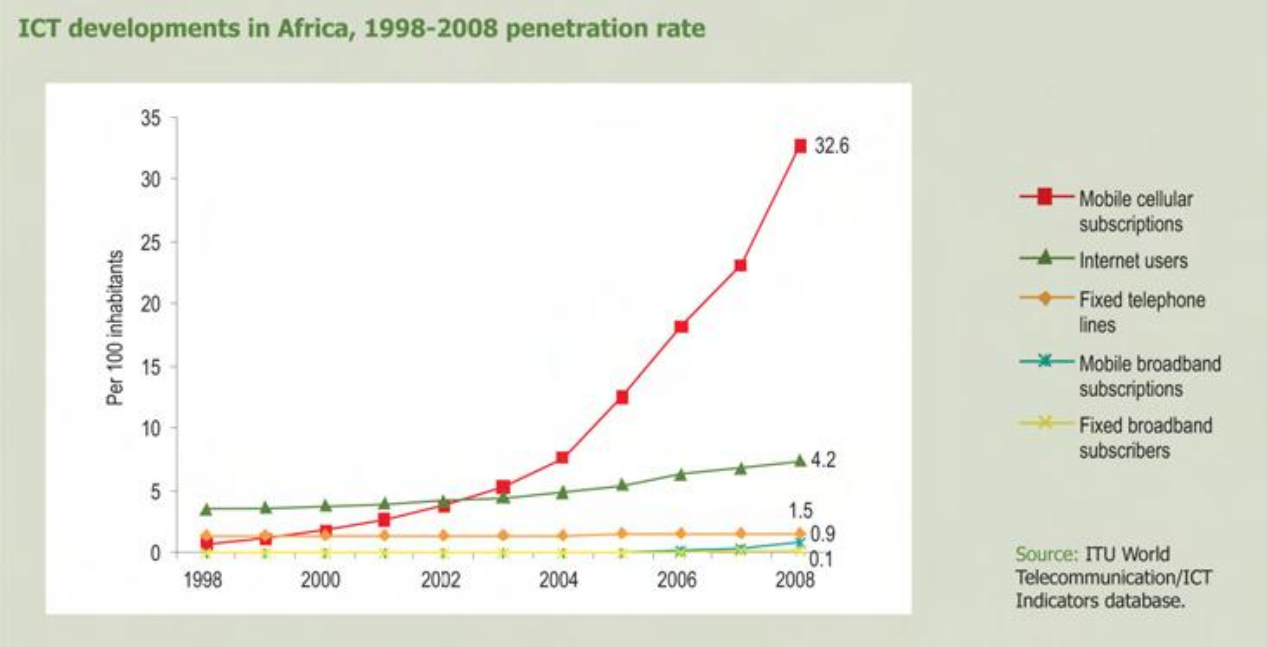

Figure 11. Not only an increase in the fiber-optic cable infrastructure took place in Africa in the last decade. It was accompanied by internal increases in connectivity predominantly represented in the wireless sector that does not rely on expensive physical infrastructure in order to exist.

Figure 11 shows the continent wide penetration rate of different ICTs. Notable here is the huge increase in wireless penetration – almost 33% continent wide. This continent wide picture does not paint a fully accurate picture. While the overall number is correct, the penetration rates in North Africa show a different story when reviewed separately. Too much variation is concealed in the overall continental rate but becomes apparent when examined more regionally. In the Mahgreb, the rates were almost twice as much as the continental average and increased

steadily to over 100% in some places meaning that some subscribers actually had more than 1 phone by 2010.

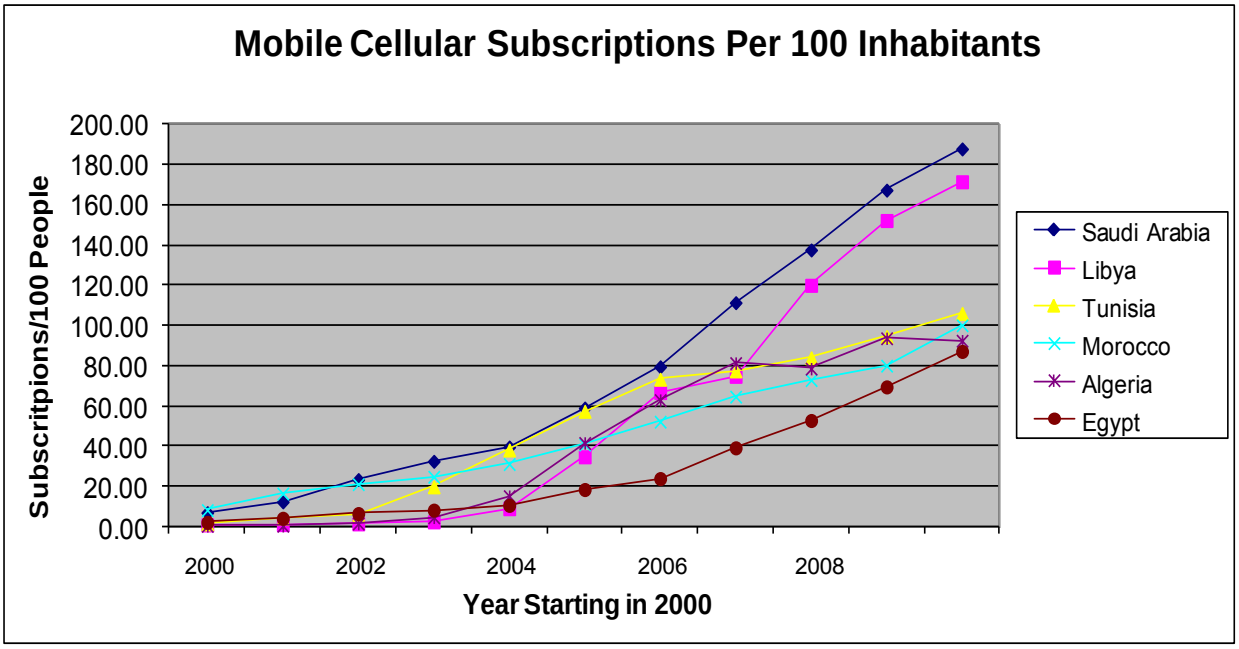

Figure 12. These numbers taken from the same database but broken out regionally show the huge difference between the average continent penetration rate and the penetration rate of ICTs in Northern Africa. While the continent wide rate was almost 33% in 2008, it was easily almost double that in the Mahgreb and by 2010 was over 80% regionally. If the penetration rate can be viewed as a predictor of political unrest, then the period of 2012-2014 might prove very interesting in Sub-Saharan Africa as ICT penetration rates continue to increase. Original graphic by M. Thomas. Data source: ITU World Telecommunication / ICT Indicators Database

Figure 12 shows the steady increase in areas of the Arab world and North Africa in particular. Saudi Arabia is contrasted here as a reference for other parts of the Middle East. The steady growth in the penetration rate has created a climate where anyone can speak to anyone else – and as a result provides a possibility for change based on mass communications when repressive regime has lost control of the "message."

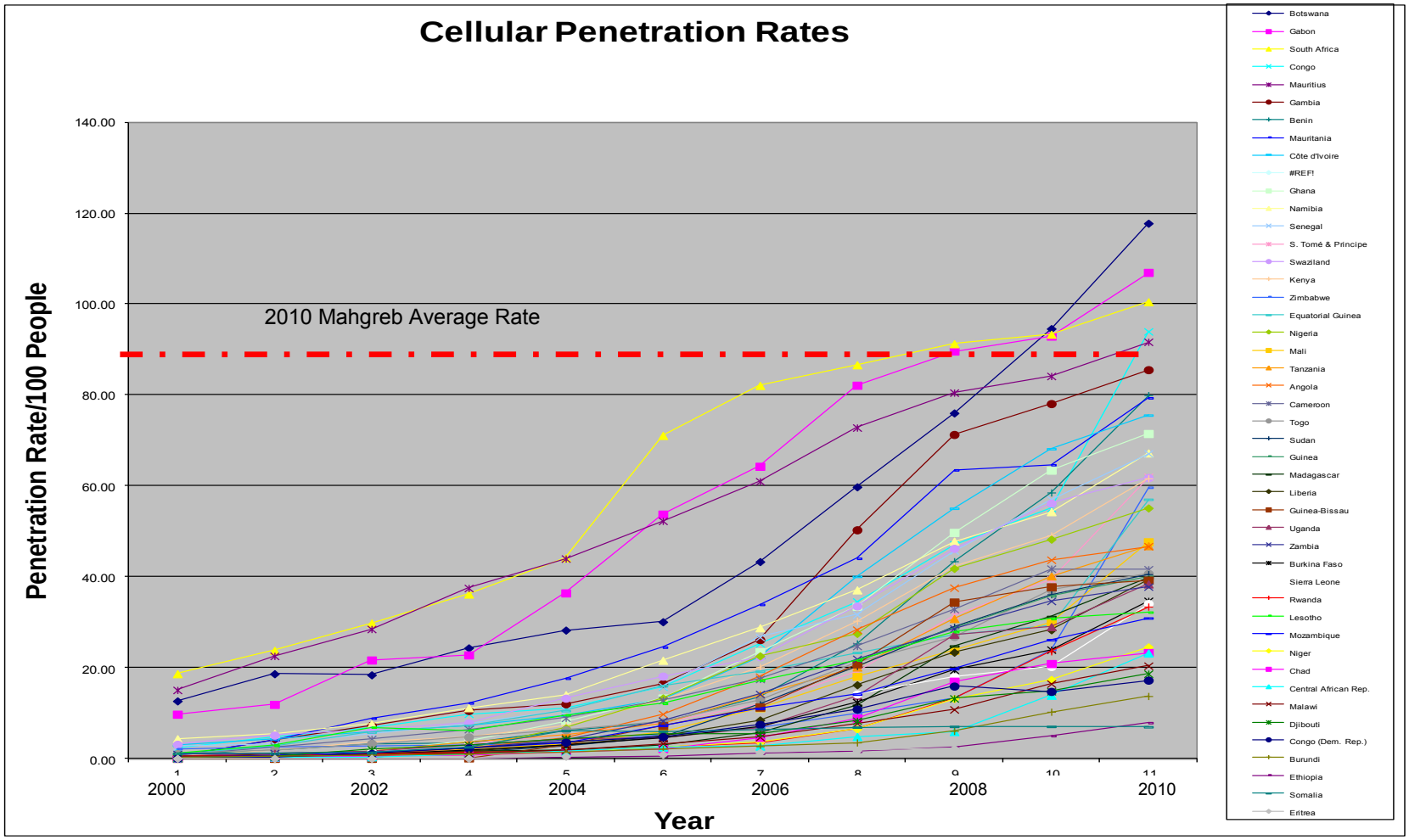

Figure 13 showing the rest of Africa compared to the 2010 average rate in the Mahgreb. While there are areas of almost full penetration, most of Sub-Saharan African lags the North in development. It is coming – albeit at a rate slower due to the remoteness of many areas as one factor. The 2010 rate in the Mahgreb might be the threshold rate that facilitates change. When everyone can speak, text etc. with everyone else, a dictator can no longer control the message. Data source: ITU World Telecommunication / ICT Indicators Database Original graphic by M. Thomas.

Geographic underpinnings are one thing. Online spatial analysis is another. One example where of this is has actually been accomplished is the website http://www.lracrisistracker.com developed by the Invisible Children Network[33]. Its stated goal is to publicize the atrocities of the Lord's Resistance Army (LRA) and provide an early warning mechanism for remote parts of central Africa on the group's location and movements. The group makes use of an HF network established and maintained by missionaries in the tri-border region of the Democratic Republic of the Congo (DRC), South Sudan and the Central African Republic (CAR). By monitoring reports of the movements of the LRA and broadcasting them over the network, they provide an early warning capability using an infrastructure in an underserved area. Publishing the data on the web using basic geospatial analysis techniques (hotspot analysis) provides an intelligence product that can be leveraged by security forces in the affected areas whose history of interactions has been typified by interstate conflict. This data source and the analysis provides near real-time intel unavailable from other sources and might be used to mitigate the freedom of movement that has been enjoyed by the LRA over the last 25 years.

[33] On their website http://www.invisiblechildren.com, they state, *"Through partnering with local Ugandan and Congolese leadership, Invisible Children has identified gaps in humanitarian assistance that currently exist in LRA-affected regions of Central Africa."*

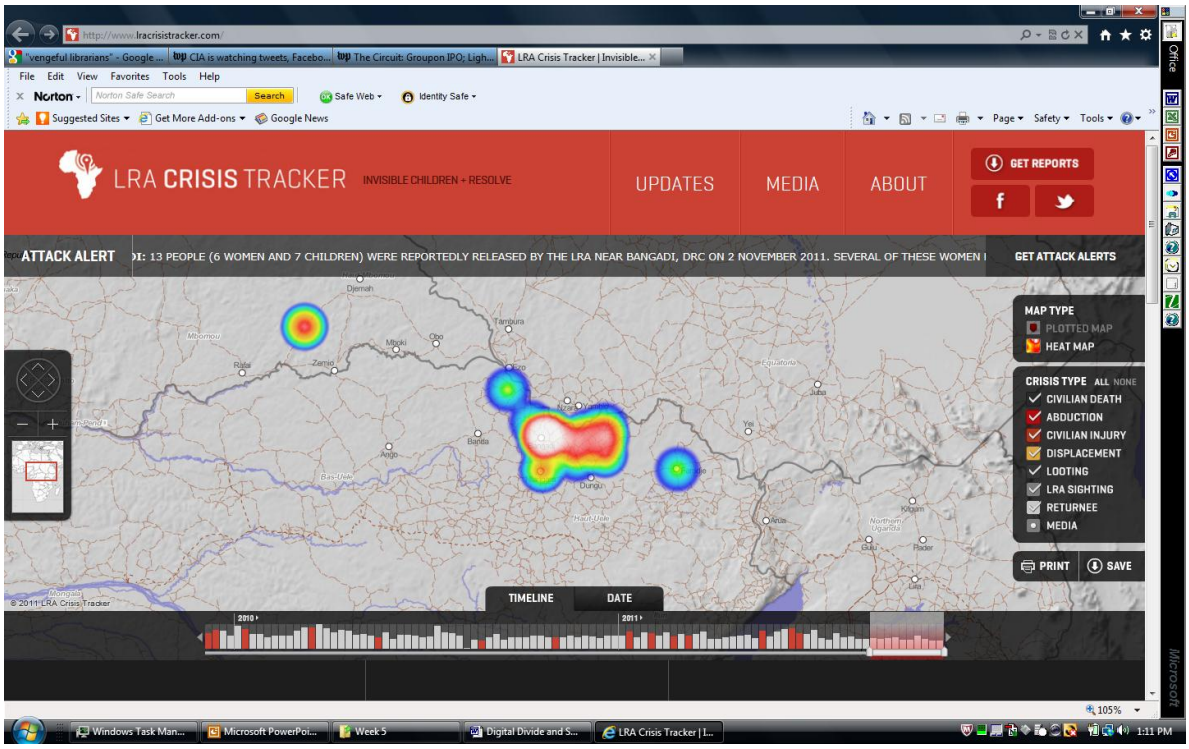

Figure 14. Hotspot analysis available online of activities of the LRA in Central Africa. Basic resources and Cyberspace have provided a source of real time Intel previously unavailable. Accessed on 6Nov2011 from http://www.lracrisistracker.com/ .

Summary. On reflection of the previous pages it might be helpful to summarize the previously established points.

1. There is a documented set of literature and studies going back to the 1950's that defined what has been called the "digital divide" that documents the disparity between segments of the population to access to ICTs and information.
2. Notable security analysts have characterized the non-served areas as the most likely to require the use of US military forces for some type of intervention.
3. Even in challenging economic times, the continued growth of ICTs continues to be the norm.
4. Attempts to map both the internet and where explicit knowledge is located has been frustrated by a lack of understanding of the synergies between such diverse fields as communication theory, geography, economics, GIS, and strategic studies – among others.

5. Maps (geospatial information) are powerful communicators of information and can be agents of change in the geopolitical context.
6. ***Information is physical.*** Geospatial information is physical. Explicit information cannot exist without a physical infrastructure to support it. Cyberspace is created as a domain by this infrastructure and has a geospatial component as well than can be expressed as a set of septuple coordinates associated (connected) through the ICT infrastructure.
7. The ICT infrastructure provides the possibility of a transaction based relationship between distant points that extends the application of Tobler's 1st of geography.
8. As ICT infrastructure increases, access to information increases. Social change is more likely in areas where this increase is occurring.
9. There is an intelligence value to the phenomena of the messages sent over such ICTs as social media. These messages have a geospatial component.
10. The intelligence value is recognized in the IC and studies at leading universities are being funded by the IC to further the Body of Knowledge (BOK) in using new HUMINT sources found in the Open Sources.
11. Current understanding and practice of Cyber Intelligence is limited to attacks and defense on the infrastructure.
12. Cybergeomatic Intelligence is more concerned with the geospatial context and content of the information as an intelligence source. Patterns exist in the communications that can be documented and these patterns have an *underlying* geospatial layer.
13. Bodies attempting to censor the flow of information tend to provide blocks on the infrastructure and ignore or are incapable of monitoring and exploiting the sources of the

communications. Needing the connectivity to function, the blocks are soon lifted when the impression of "control" seems established.

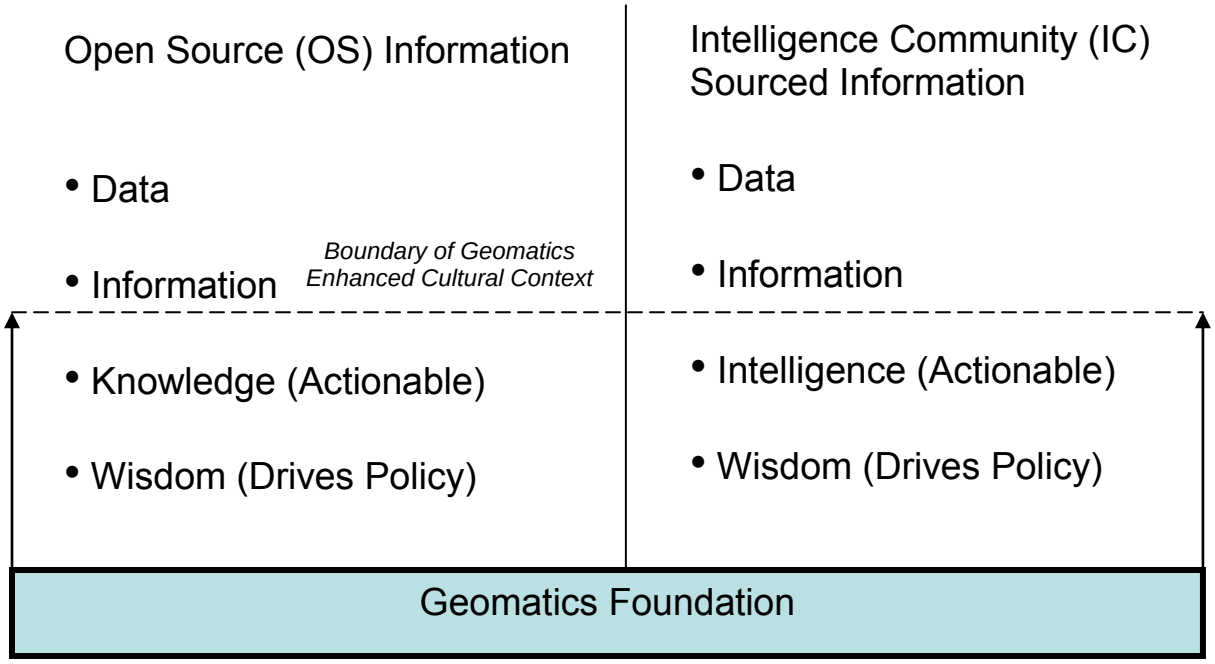

Figure 15. Relationship between Knowledge generated in the Open Source vs. generated within the Intelligence Community. The line between the two represents a 1-way communication path from the Open Source to the IC. Underlying both is a context rich layer with Geospatial underpinnings. This foundation adds context but decrease in effect as it moves upward in the information hierarchy. Original graphic by M. Thomas. In a perfect world, wisdom serves as an input to policy.

Conclusions. Among the "J" codes in any military organization, the J-2 stands alone when it comes to sharing information – even among themselves due to the caveats on the sources. Knowledge flows relatively freely from the other "J's" and from outside sources to the J-2 domain but it is trapped there amid numerous classification compartments depending on it's sensitivity. This will simply not be practical in the future. The richness of available open source, generated either by social media of other sources is too complex to accumulate and analyze using current approaches. Currently, analysts often use multiple sources of information in order to create actionable Intel for a mission. The datasets are large in volume, and are likely stored in

multiple databases and multiple locations. This requires tailored queries into the systems to be pre-specified, filtering significant amounts of data before an analyst has an opportunity to decide if it's important. This query-retrieve paradigm effectively removes the possibility of the "lucky find," because the analyst has to already know what they want to query. Looking forward, the datasets are becoming more connected (as seen in Figures 3a and 3b) and the transaction costs (as seen in Figures 7 and 10) are decreasing. The volume of pseudo-humint available from social media is one result of the increase in this connectivity infrastructure and the impacts are both unpredictable and unforeseen. At a minimum, it raises the following questions for follow-on research:

1. Social media content, themes, locations, key words, and retransmissions can all be additive in value to the production of intelligence products. *But now what?* What do you do with the information you have derived?
2. What biasing influences might exist in the social mechanisms and how can they be quantified and accounted for? Are there unique statistical distributions associated with them?
3. How do we measure and improve the reliability (and thereby increase our confidence in) the new models?
4. What type of information is being requested and queried by region where the new infrastructure has been placed?
5. What is the effect of the information flow by region?
6. What does the feedback of information back into the global grid look like?

7. The tacit-explicit knowledge transformation underway is potentially making disconnected areas such as Africa less a "Terra-Incognita" than ever before. What will this mean in terms of the geo-strategic framework?
8. How seriously is the IC reviewing the potentials of Web 2.0 enabled sources geospatially enabled with "Volunteer Geographic Information?"
9. Beyond a septuple coordinate system, how do we broaden the depth of understanding of the mathematical spatial statistics and what new models are needed to further "spatialize" the virtual space?
10. How will the new models apply to Violent Extremist Organizations (VEOs) be identified and the diffusion of extremist ideas be represented spatially?
11. How might peer and near peer opponents make use of the models?
12. How will "organizations" strategically apply mass collaboration?

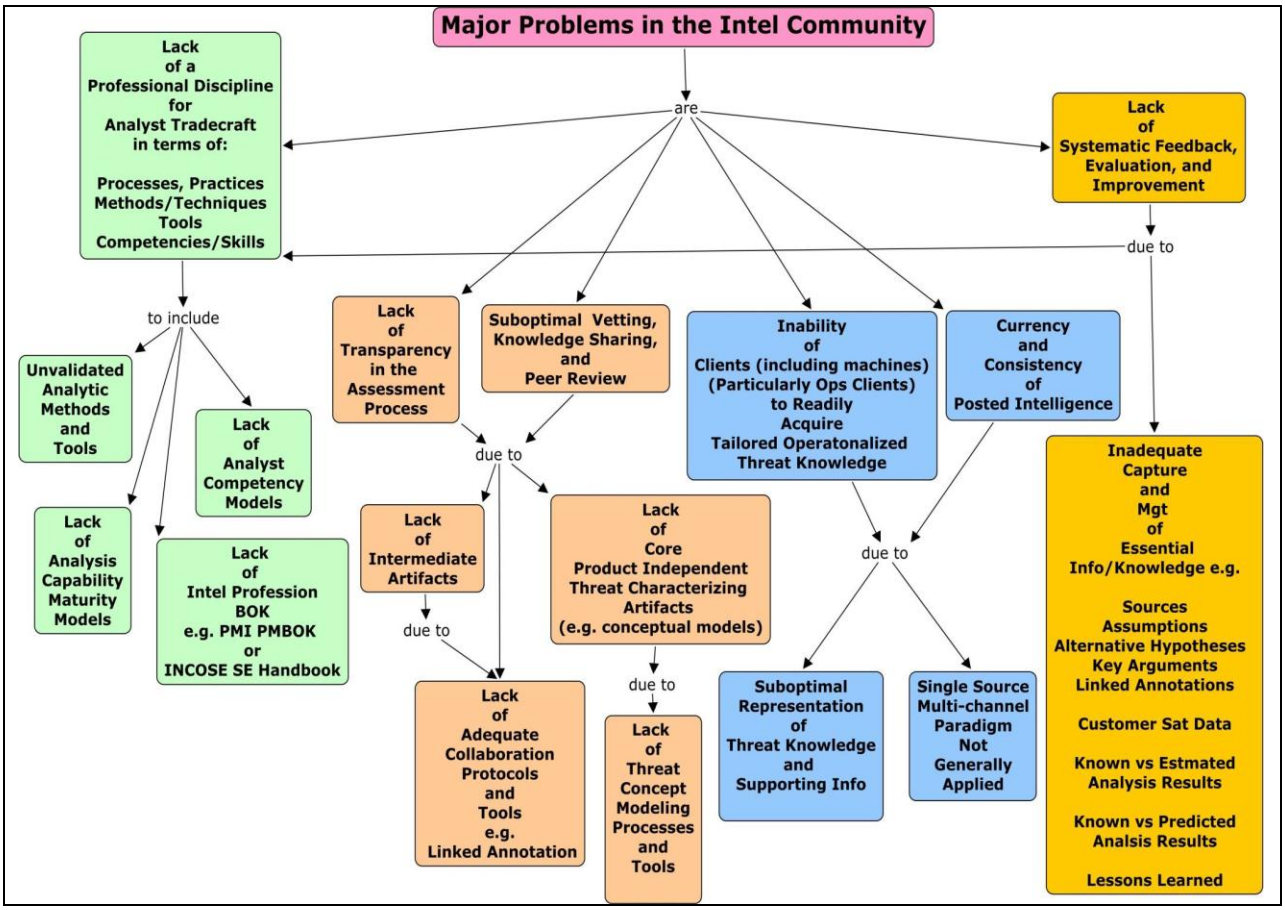

Figure 16. Questions and KM issues identified in a Entity Relationship diagram. This represents the "as-is" of the current lack of management of collaborative technologies that abounds the IC.

The current DNI hinted at some answers in a recent interview[34],

> *"I see all kinds of benefits (from combining collection and analysis). There are a lot of examples that I can't cite because they are classified.* ***But I will say that I think we will be better able to address an Arab Spring, for example, and better able to anticipate it and respond to it…"***

[34] Gen Clapper granted this interview in Geospatial Intelligence Review, Dec 2011. The full interview is available at http://www.kmimediagroup.com/files/GIF%209-7%20FINAL(1).pdf

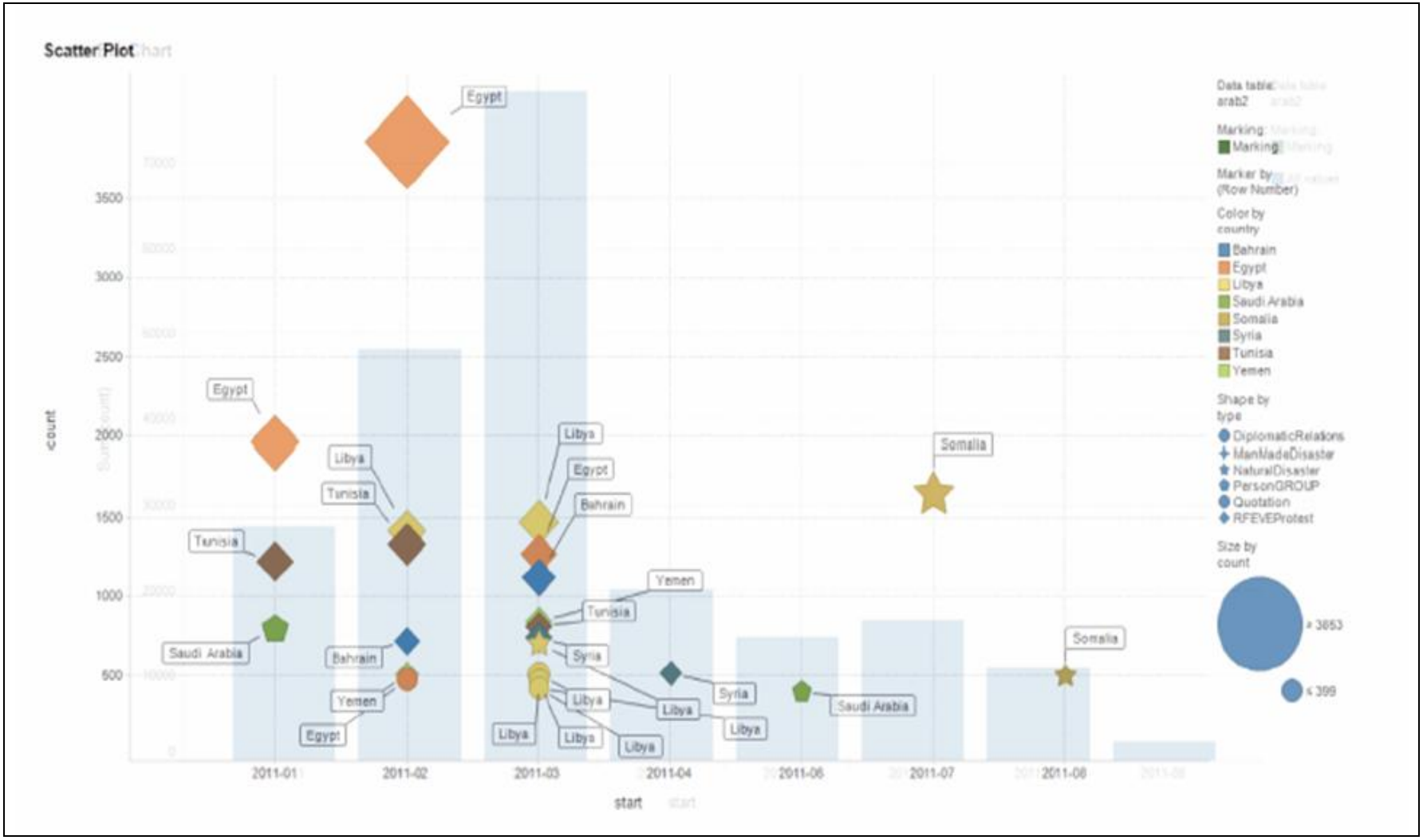

Figure 17. Here, events for 22 Arab nations, from the beginning of 2011 and up till the beginning of September 2011, were extracted and clustered. The grey bar chart shows the total volume of events per month, and the icons are clusters of events, per country. The icon shape signifies the event type ('diamond' for Protest events, 'star' for Natural Disasters, 'circle' for Diplomatic Relations, 'pentagon' for Person related events, etc.). It is can easily be seen how the events move from country to country, and also which events are most common.

One of the technologies being funded and evaluated by both InQTel and Google is one called "Recorded Futures." The company's premise is that the web is filled with temporal signals that include not only historic events that have transpired but also of events that are expected to occur in the future.[35]Their software algorithms extract time related references and using both statistical and linguistic modeling to "structure the unstructured" using what is described as a temporal analytics engine. With this information, questions can be addressed such as "*Which heads of state visited Libya in 2010?", "What pharma companies are releasing new products in the first quarter of 2012",* and *"What do French bloggers say about the earthquake in Haiti?".* The company highlights the power of merging any inputs from the web, including social media and then forecasting and visualizing the results geospatially. "Our mission is not to help our customers find web sites or documents, but to enable them to understand what is happening in the world – to record what the world knows about the future and make it available for analysis."[36]

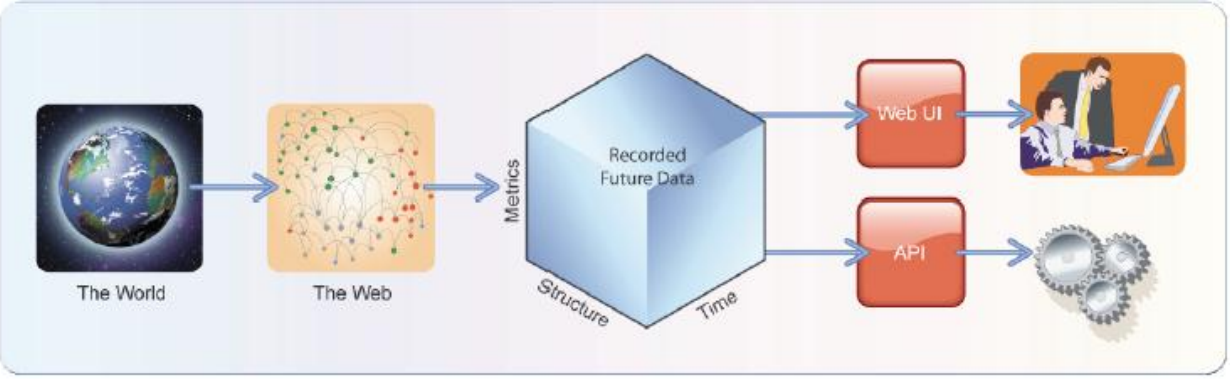

Figure 18. One proposed key to prediction of future events is using the Metrics-Structure-Time hypercube approach. Gathered from unstructured text (stories, blogs, tweets, corporate earnings reports) the data is structured and combined with contained ontological mentions of time. A key metric is "momentum", which is computed based on the volume of news around a certain entity or event, and also on the contexts in which is mentioned. Other metrics include sentiment (positive or negative tone, use of violent language, etc.).

[35] As described on the company website located at https://www.recordedfuture.com/about/ accessed 17Jun2012.
[36] From a company White Paper downloaded from http://blog.recordedfuture.com/wp-content/uploads/2011/10/BigDataWhitePaper.pdf on 17Jun2012.

In recent years a series of disasters such as oil blowouts, hurricanes, tsunamis has resulted in the development of numerous mapping Web applications designed to provide information to the public, relief organizations and even the US military in order to better facilitate contributions to support crisis management. Crisis Mappers counts over 70 deployments of crisis mapping "teams" worldwide in response to such events.[37] Such a volume of activity is no longer being ignored but presumably embraced by the IC if we can infer interest from Gen Clapper's comments.

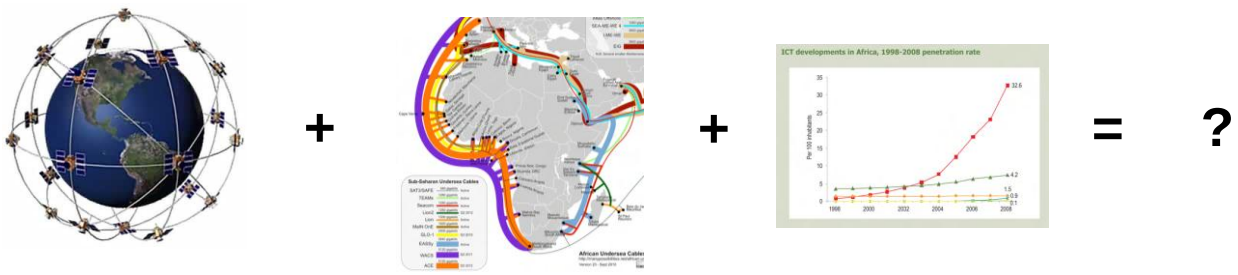

Figure 19. Using Africa as a Meta-model, the combinations of 24-7 GPS location technology (external infrastructure and global in nature), the exponential increase of external connectivity of fiber optic planned or already installed since 2009 (external infrastructure and regional in nature) and the exponential growth of the wireless phone market (internal infrastructure and local in nature) makes the future of the continent as a whole unknowable using current methods. What has already occurred in the Mahgreb may pale in comparison with what's to come in the near term based on the impact of georectified enabled ICTs in sub-Saharan Africa. Original graphic by M. Thomas.

With this understanding of the geographic nature of Cyberspace, we have to ask, is it possible or even practical for the IC to attempt to exploit it as a "source"? It is part ELINT, part EMINT, part HUMINT, part OSINT and part CYBERINT, and hence needs its own name as proposed earlier – ***CyberGeomatic Intelligence.*** The area of interest (AOI) is a place with people gathering there (*what characteristics about a place is drawing people to it?)*, or the AOI is a group of people gathering in a place with other people already there *(why are people*

[37] A complete list of events since 2009 can be found at http://crisismappers.net and https://spreadsheets0.google.com/ccc?key=tqNtll3igMBWP4w-UHf2gPg&authkey=CMTsxqsP#gid=0 .

following other people to a certain place?). These correlate directly with current understandings of first order and second order effects in Geospatial Statistics. Once these factors are understood in the context of Spatial Statistics, then the focus and emphasis can be on what the information effects and *outcomes* are likely to be and the effects on the geopolitical arena. What the "crowd" will potentially accomplish becomes the new focus – even as the definition of "crowd" will have to be re-examined since "place" is going to have to be re-examined as well.

Tobler's first law is alive and well and more relevant than ever.

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