Global Geodetic Reference System in Support of Location based services

UZOCHUKWU OKAFOR
SURVEYOR-GENERAL
NAMIBIA

Global Geodetic Reference System in Support of Location based services

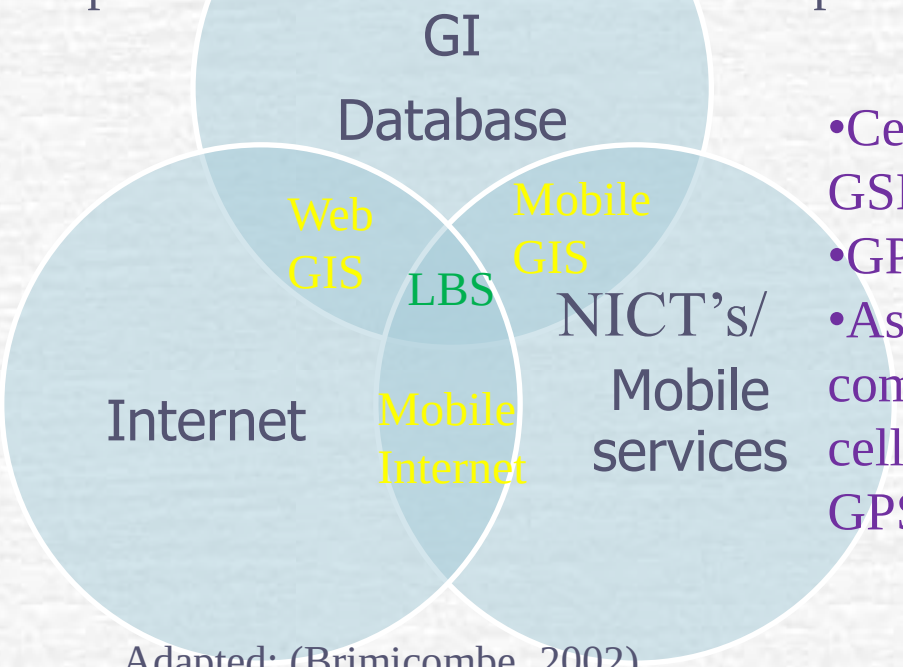
UZOCHUKWU OKAFOR
SURVEYOR-GENERAL
NAMIBIA

OUTLINE

1. Location Based Services
2. GNSS Services
3. Issues in Location Based Services
4. Recommendations
5. Conclusion

Definition of LBS

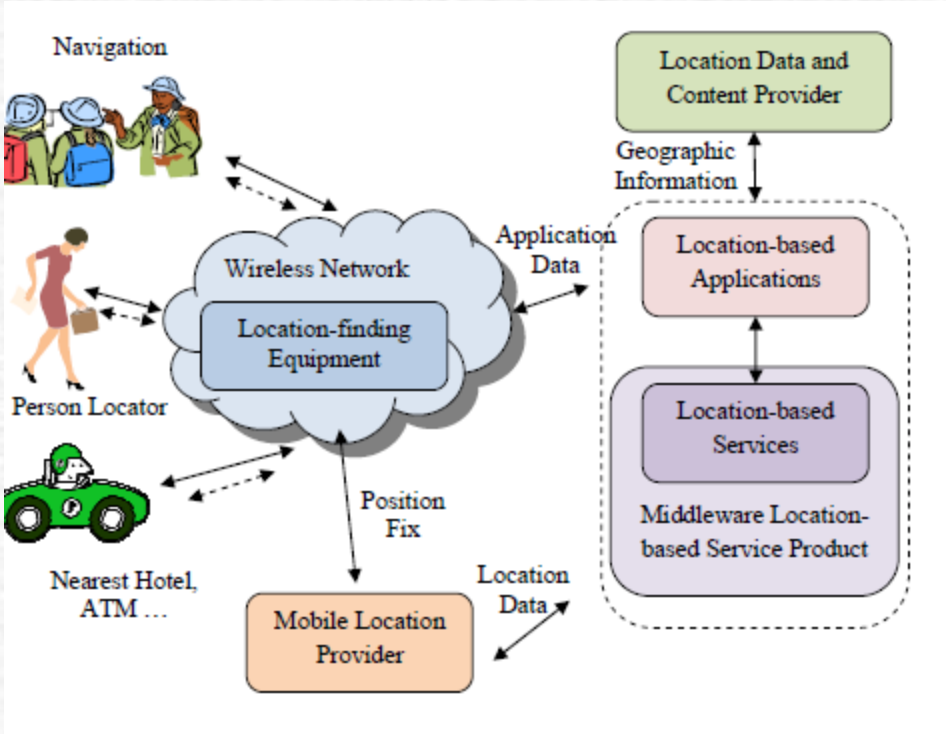
A wireless IP service that uses geographic information to serve a mobile user (OGC, 2005). Leverages a user's current physical location to provide an enhanced service or experience



- Cell ID used in GSM/3G networks
- GPS
- Assisted GPS – combination of cellular networks & GPS

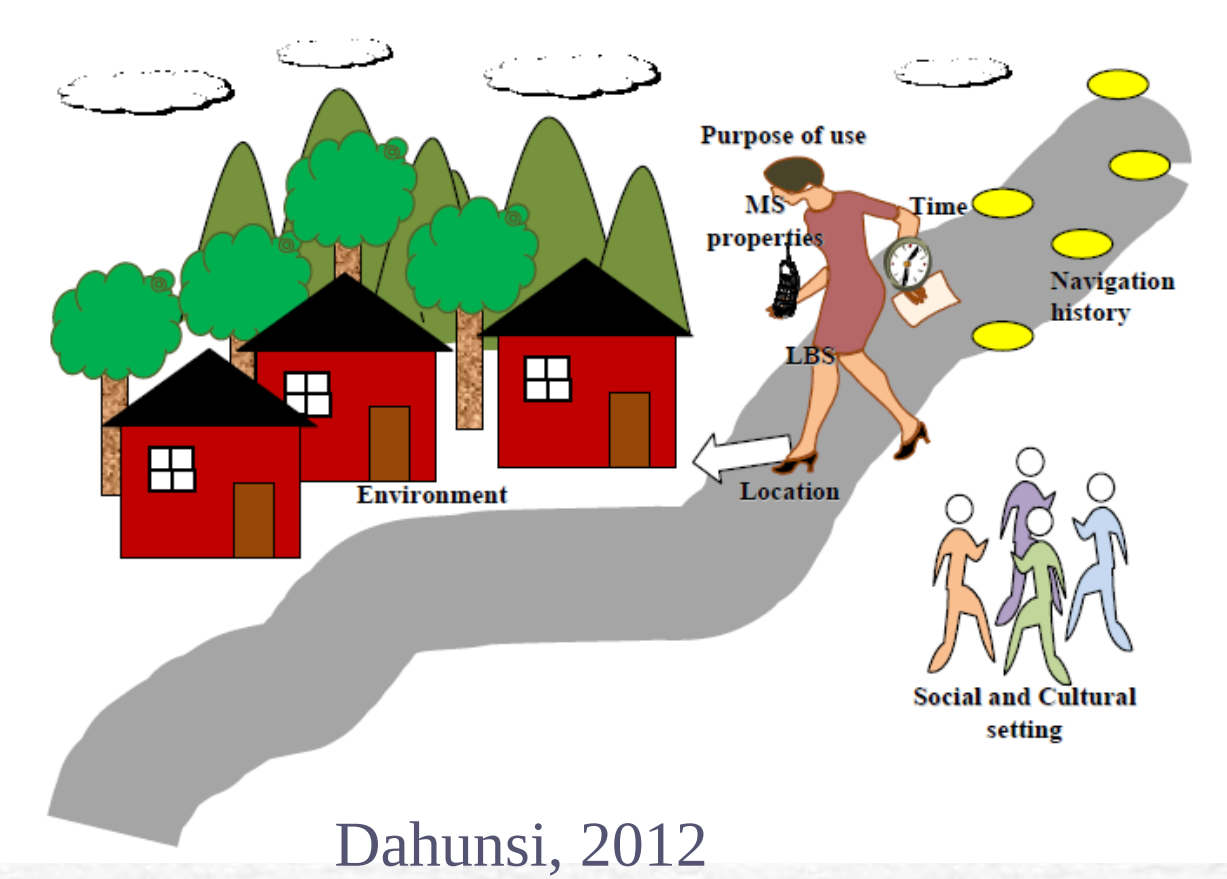
Adapted: (Brimicombe, 2002)

Location Data Information Available to LBS User



Dahunsi, F.M., 2012

Different Types of context in LBS



Dahunsi, 2012

DRIVERS OF LBS

- Explosion of smart phones, deployment of high speed broadband wireless infrastructure, digital cameras & GPS integrated circuits
- Surge in social networking tools
- Degree of fit between technical feasibility & marketing strategy guiding its use (bottom line $$- mobile advertising could exceed $12 billion by 2014 – (Shek, S., 2010)

DRIVERS OF LBS

- Shift in consumer preferences
  - Quest for seamless integration of location information, customer needs $ vendor offerings
- Regulatory pressures forcing Carriers to accurately position wireless emergency calls – E911 in the US & E112 in the EU.
- Demand Drivers
  - Point of need information
  - Niche Consumer applications
  - Industrial/Corporate

DRIVERS OF LBS

- Navigation with maps & GPS- primary Drivers
  - Finding friends (22%); Locating venues (26%); checking public transport (19%); checking in to social networks (13%) –interest in Location-based social networks rising 50% on 2011's data – Rusell, J., 2012)

Evolution of LBS

Date	Event
1996	Authorization for SA of GPS signals to be removed, implemented on 2 May 2000
1998	In the USA, cellular network providers compelled to provide the location of 911 calls as part of Enhanced 911
2000	Java Micro Edition standards first approved
2003	JSR 179 Location API reaches final release
2004	Qualcomm announces first successful test of assisted GPS on mobile phones (www.3G.co.uk, 2004)
2005	Google maps goes live (February). Google maps API released (June)
2006	Google Maps for Mobiles released

Evolution of LBS…

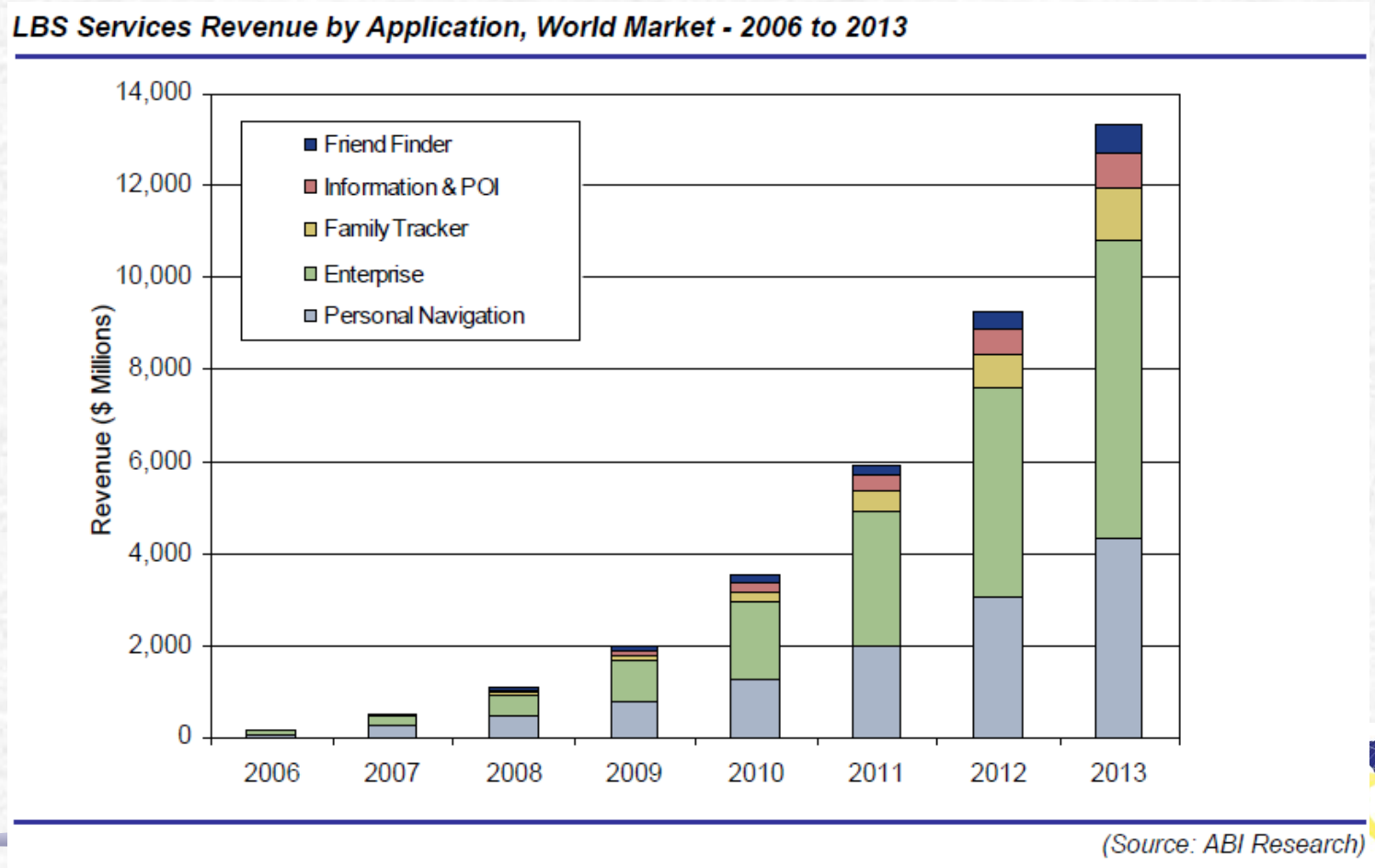
Year	Event
2007	Apple releases the first iPhone; Wifi positioning
2008	Apple releases the App Store for iPhone -August
2008	The first Android-based phone is released (HTC Dream) – october – Wikipedia HTC Dream, 2010)
2009	IBM Seer application for wimbledon released, running on Wikitude augmented reality browser –June (Mobilizy, 2009)
	Galileo – 5 dB improvement in signal power, ranging code signal that enables tracking of signals in extremely noisy environment, broadcast over wide bands –improved robustness/ to multipath

Evolution of LBS…

Evolution of GNSSs is improving the performance of LBSs as more satellites become available & accuracies improve.

Steve Jobs in the Apple iconic iPhone transformed simple geographic coordinates into popular applications emulated by location services like Foursquare, TripAdvisor & Facebook Places

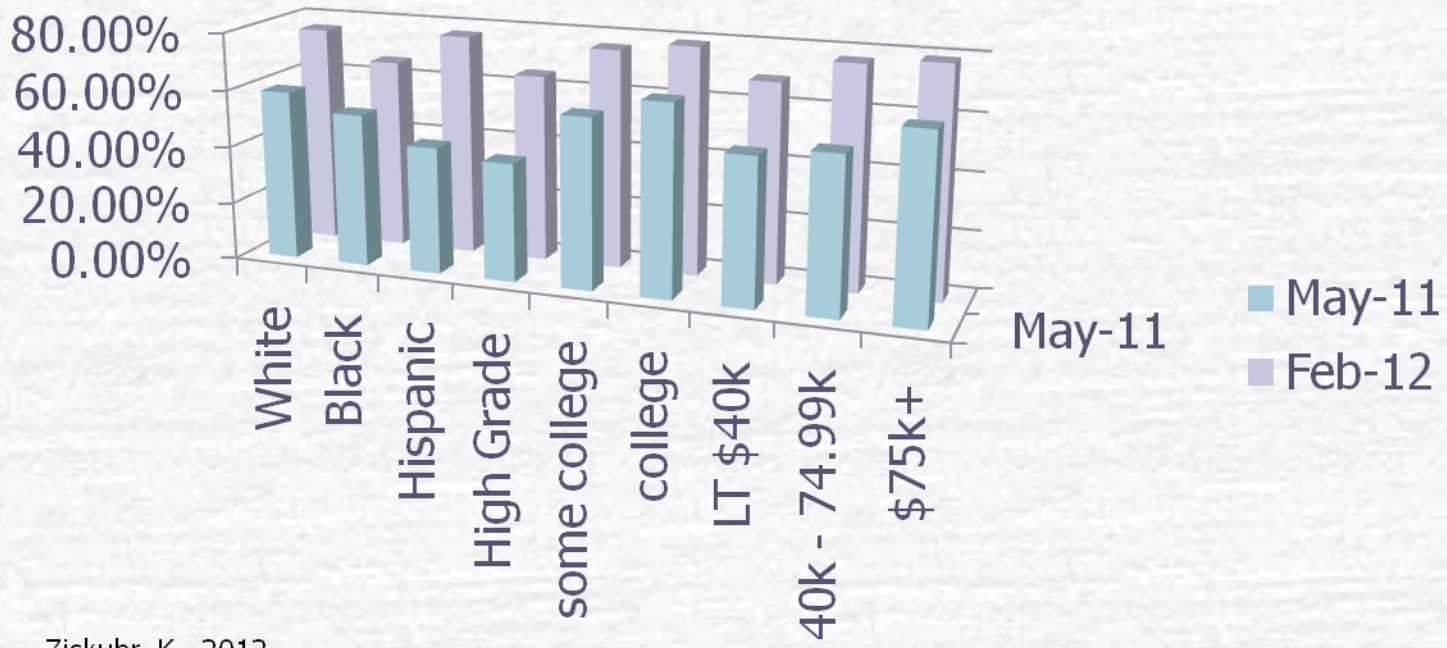
Location based service (LBS) will become a 13B business by 2013



Market Forecasts

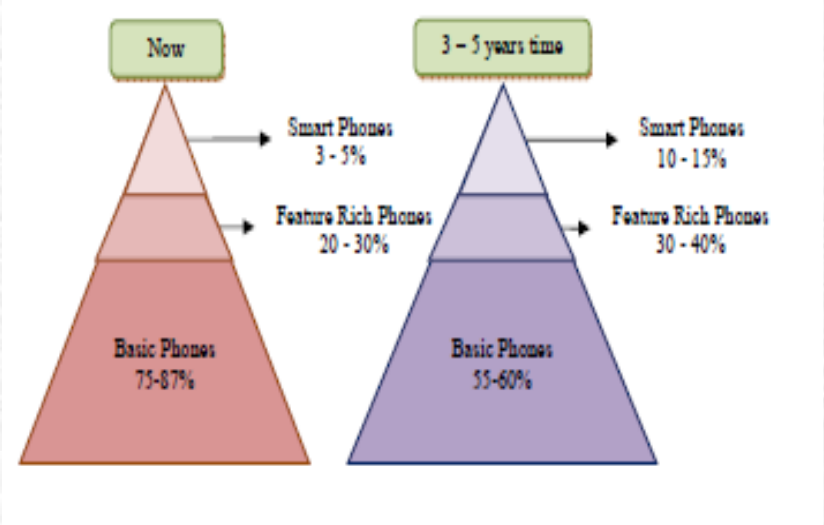
- Market forecast undertaken for Galileo by the EC funded by the EC suggests that LBS will be the prime application wrt No of users & revenue potentials
- Revenue from Middle East and Africa by 2013 - $20 million (13B) $60 million by 2014.
- Traditional Advertising for Middle East & Africa –
  - 2012 = $150 million; 2015= $300 million; 2017 = $360 million – (Johnson, L., 2012)

Demographics of USA phone users making use of LBS applications



Zickuhr, K., 2012
Pew Research Centre's Internet $ American Life Project

Availability of Different classes Mobile Phones in Africa



Dahunsi, F.M., 2012

Location Based Services in 4 African Countries

Country	Company	Penetration Rate	Services
Egypt	Mobinil, Vodafone, Etisalat	58% (05/2008) 66.3 million	
Kenya	Safaricom, Airtel-Zain, Orange Kenya, Yu-Essar telecom Kenya	51% (10/2010) 19.4 million	Vehicle tracking, emergency calls
Nigeria	MTN, GloMobile, Airtel-Zain, Starcomms, Mtel, Etisalat, Multilinks – Telkom Visafone	60% (10/2010) 90 million	Person tracking

Location Based Services in 4 African Countries

Country	Company	Penetration Rate	Services
South Africa	Vodacom, MTN, Cell C, 8.ta, Virgin Mobile, Red Bull Mobile	92% (2010) 45 million	Emergency calls, Distress calls, person tracking, points of interest, Asset tracking,

Positioning mechanisms

- Positioning with respect to LBS involves two steps:
  - Signal measurements
  - Location estimate based on measured signals
- 5 methods are widely used:
  - Mobile Positioning System (MPS) based on Cell Global Identity (CGI)
  - Cell Global Identity + Timing Advance (CGI + TA)

Positioning mechanisms

- Uplink Time of Arrival (TOA),
- Enhanced Observed Time Difference (E-OTD) and
- Global Positioning System (GPS) assisted.

Satellite Based Position

GNSS Augmentation

Augmented Systems

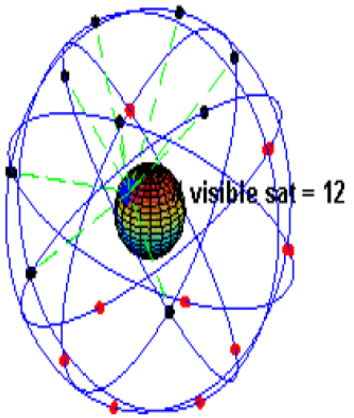
- •WAAS – Wide Area Augmented System
- •EGNOS – European Geostationary Navigation Overlay Service
- •Differential GPS
- •INS -Inertia Navigation Service
- •Assisted GPS

GNSS Development

- Whitehead, 2012

Where is GNSS heading?

GPS	30 (current)
GLONASS	24 (current)
Galileo	27 (2019)
QZSS	3 (2013)
COMPASS	35 (2020)
IRNSS	7 (2014)



Streaming More Bands: L1, L2, L5, etc

Comparison of different positioning methods (Chatre & Ludwig, 2003

Requirement	Cell-ID	E-OTD	OTDOA	A-GPS
Accuracy	Poor 200m-20km 2D only	Avg 100m-500m 2D only	Avg 40m-150m 3D	Very Good 5m-10m 3D
TTFF	Excellent 1s	Very good 5s	Very Good 5s	Very God 5s
Roaming	Excellent	Poor	Poor	Excellent
Expansion	Excellent	Poor	Poor	Excellent
Comp	Excellent	Poor	Poor	Excellent
Terminal Cost	Negligible	Medium	Medium	High
Overall cost	Excellent	Poor	Average	Good
Summary	Average	Average	Average	Good

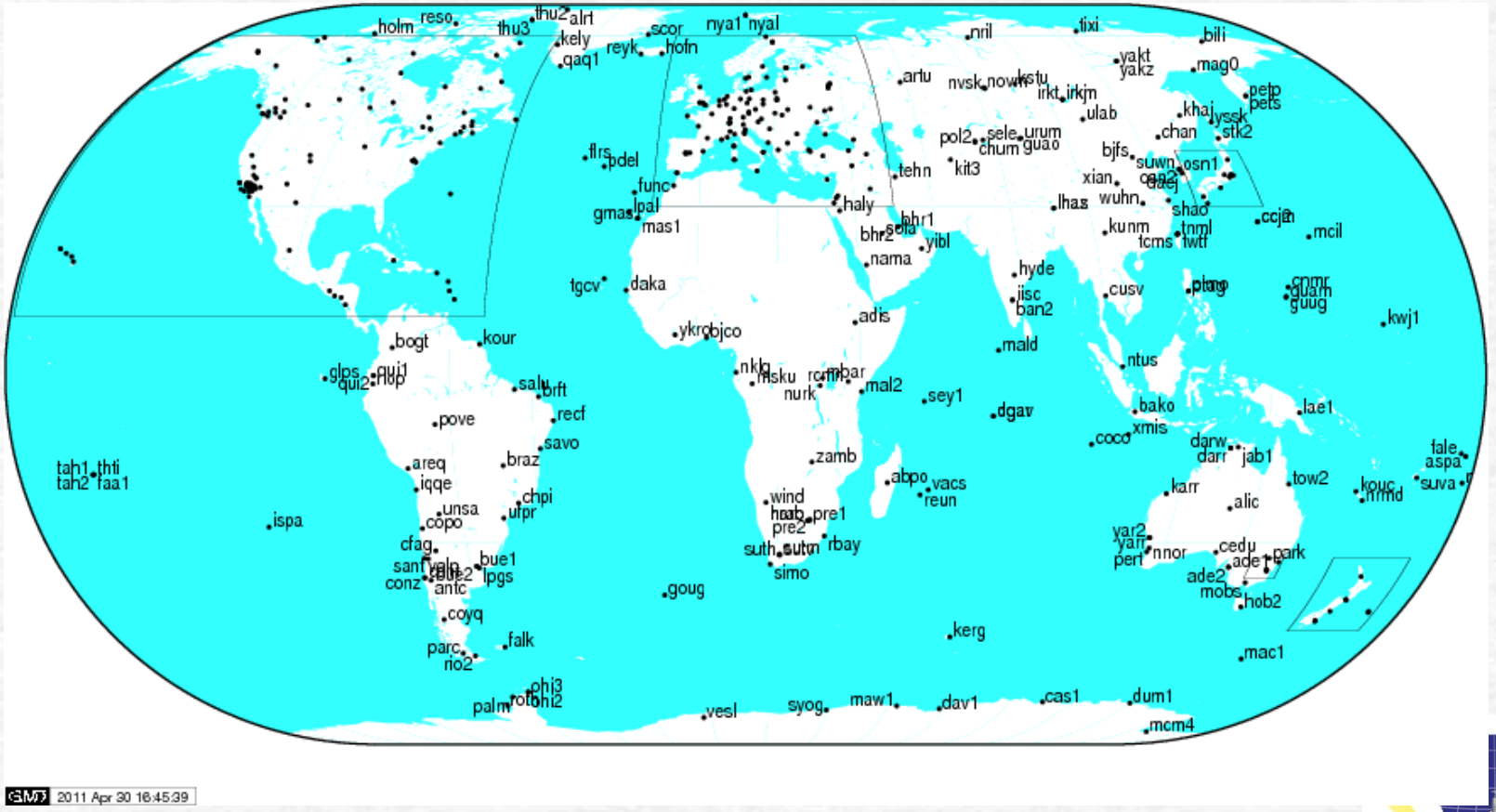
GNSS Services

- The ability to provide time-dependent coordinates to features is fundamental for many location based applications
- A well defined global reference frame is essential for any meaningful and exploitable point positions
- Global and Regional applications rely on the availability of ITRF
- Components of the precise geodetic infrastructure combine in the realization of the ITRF.

International Terrestrial Reference Frame

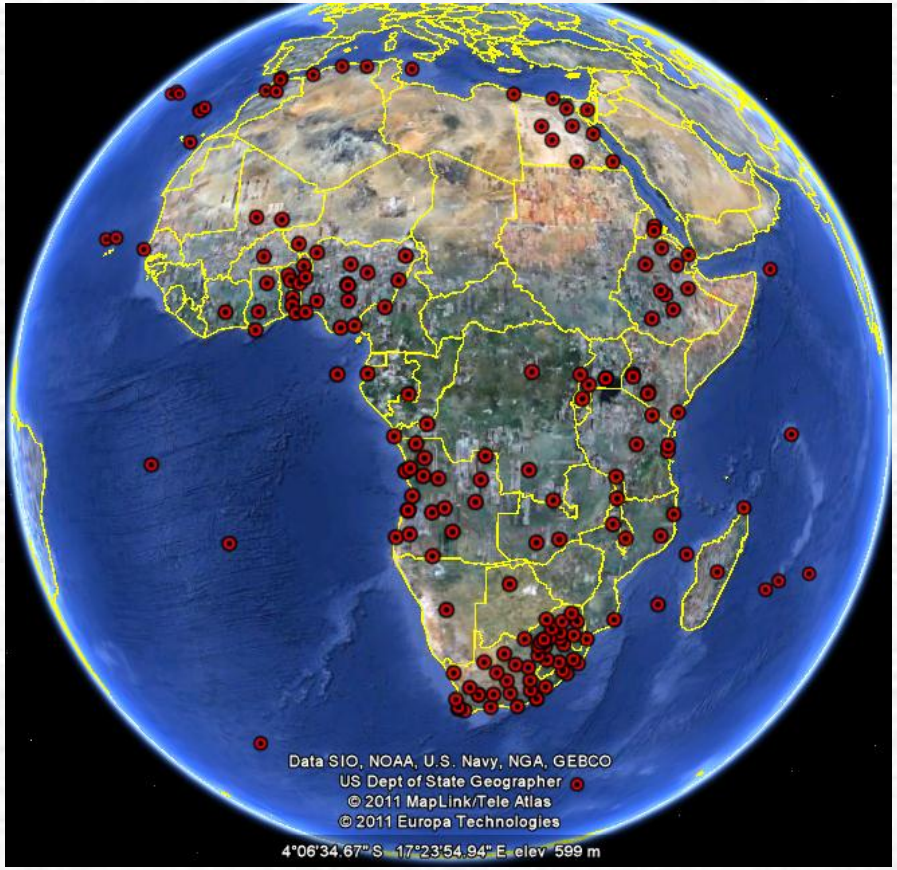
- ITRF provides the anchor for nearly all ground based applications prominent among which is the LBS
- ITRF is an indispensable reference required to ensure integrity & inter-operability of GNSS such as GPS, GLONASS, Galileo, Compass, etc
- ITRF will require sufficient number & globally distributed co-location sites

IGS Stations

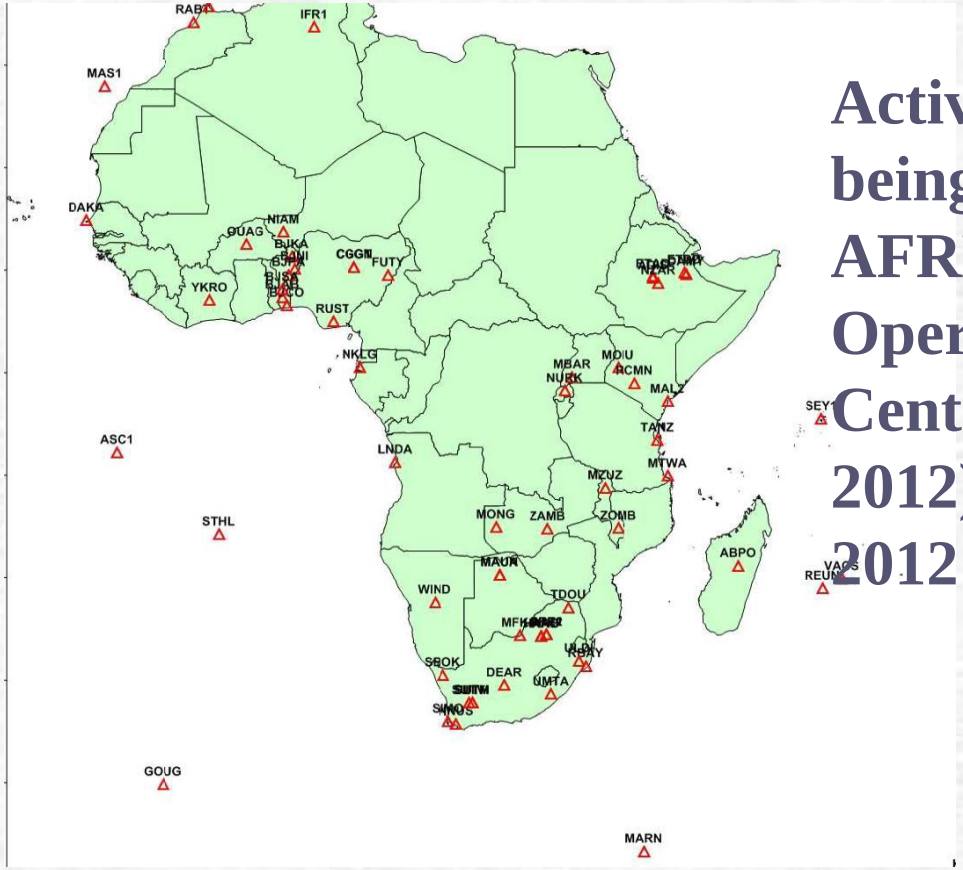


2011 Apr 30 16:45:39

CORS in Africa



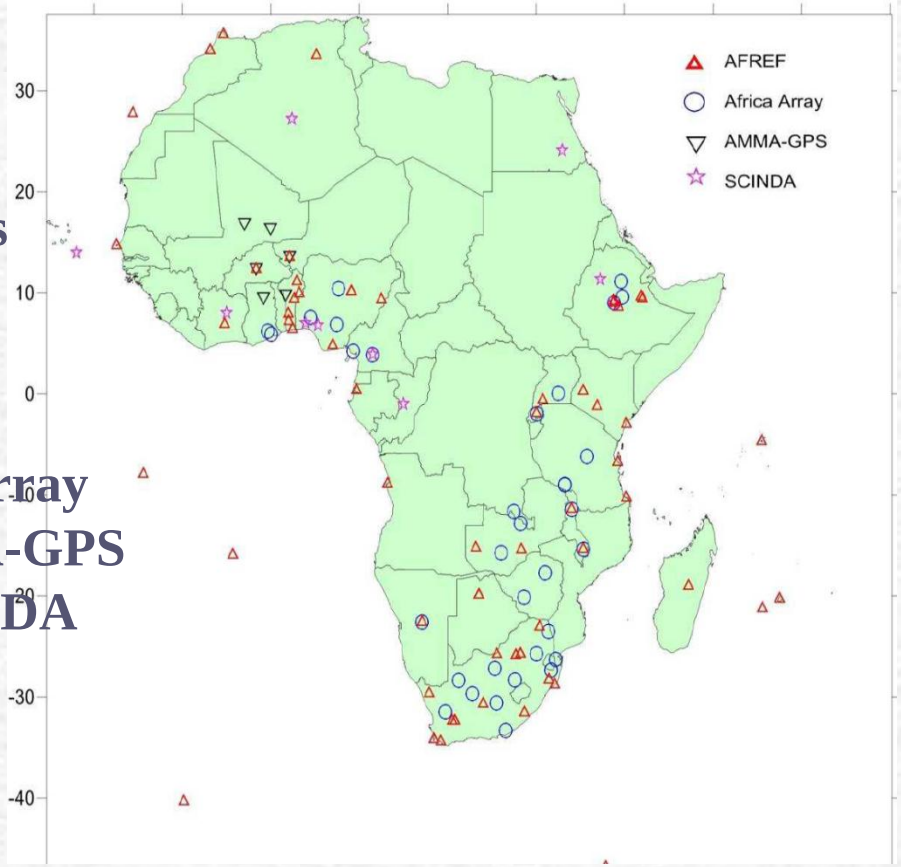
Stations Archived by AFREF



Active stations being archived at AFREF Operational Data Centre (May 2012) – Wonnacut, 2012

Inter-disciplinary cooperation

Number of disciplines make use of GNSS signal in space:
Geodesy: AFREF
Seismology: Africa Array
Meteorology: AMMA-GPS
Space weather: SCINDA



Wonnacot, 2012

Issues in LBS

- Privacy of data, ownership of position data and permissions
- Handset based vs handset assisted
- International roaming
- Accuracy due to various positioning techniques in different networks
- Inter operability with the other operators results in mass marketing the services giving the necessary critical mass

Issues in LBS

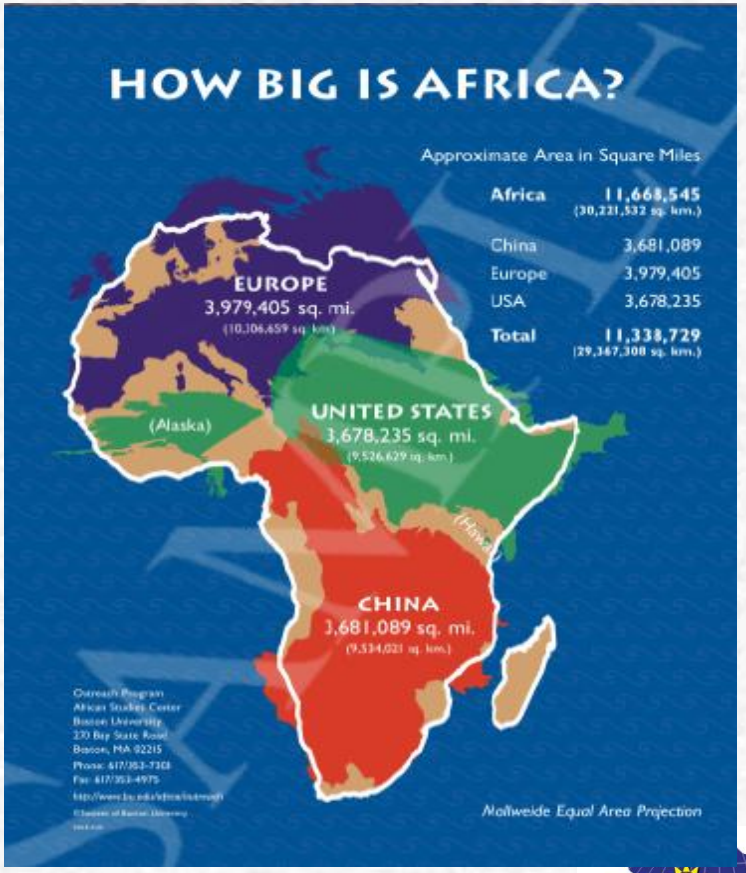
- Integration of GNSS in the Geodetic infrastructure
  - Targeted approach to establishment and maintenance of geodetic network- user "hot spots" and specific applications
  - Method of access to real time signals (e.g. Smart phones); format of data (RTCM); & level of accuracy, integrity and security.
- Non professional users with little understanding of accuracies and datum issues but with accuracy requirement exceeding that achievable without taking proper account of datum issues

Issues in LBS

- Challenge of a plethora of wireless and GNSS standards wrt the provision of equipment that employs telecom networks to improve position accuracy and speed-
  - need for A-GNSS common standard –internetworking, interoperability,
  - backward compatibility- so as not to jeopardize the implementation of existing A-GPS in the future
- For cost-effective & scalable LBS, targeting and feedback should be pinpointed and accurate in real-time at the planning, trafficking, creative and management levels.

Issues in LBS

- No regulatory body on LBS Services QoS not assured
- Limited cell density – drop call rates translates to reliability challenges with LBS
- Limited LBS infrastructure – location estimation devices like Location Management Unit & smart devices are not sufficiently available
- Coverage & Quality of available spatial data
- Poor town planning & address system



Wonnacot, 2012

Issues in Developing Effective Global Reference Frame

- Policy makers and the Public are largely unaware of the nation's reliance on geodetic infrastructure
  - Very limited sustainable long-term funding
  - Dilapidated and loss of geodetic stations
  - Sparse density of geodetic controls
  - Dearth of trained workforce to develop and maintain geodetic infrastructure.

Issues in Developing Effective Global Reference Frame…

- Different systems/frames although connected or related to ITRS/ITRF
  - WGS84 for GPS, PZ-90 for GLONASS; CGCS2000 for COMPASS; GTRF for Galileo; and JCS for QZSS
- Six regional geodetic organizations
  - AFREF for Africa; NAREF & SIRGAS for North and South Americas; EUREF for Europe and APREF for Asia and Pacific, and SCAR for Antarctica
  - Defined wrt the ITRS/ITRF, realised and maintained by regional entities, eg. ETRS89 for Europe, NAD83 for North America; and SIRGAS for South America.

Issues in Developing Effective Global Reference Frame…

- Shared cost of deployment and maintenance New Zealand & Australian example
  - Commercial services; via commercial system owned & operated by Govt. With real-time corrections sold to industry
  - Wholly Govt. Owned that provide access to data for post-processing with value addition by private sector for real time capability
  - Consortium infrastructure –industry, academia, government & community group share costs, maintenance & benefits with value addition and distribution provided by private industry.

Issues in Developing Effective Global Reference Frame...

- Proliferation of active GNSS vis a vis compatibility with national datums; datum fragmentation & need for homogeneous geodetic infrastructure
- Densities of Active and Passive GNSS's
- Status of classical geodetic network
- Insufficient Enthusiasm & Commitment to regional cooperation, e.g AFREF

Recommendations

- High precision GNSS national networks to be established and maintained similar to other infrastructure like roads, telecommunications and made available in real time without restrictions
- National participation and support for international geodetic services and commitment to maintaining the ITRF –IAG -Global Geodetic Observing System
- Improved funding and incentives to train requisite workforce
- Shift from legacy datums to GNSS-supported reference frames - ITRF

Recommendations

- Global Approach is needed – UN (GGIM)
  - Promote legal framework required to ensure standardization
  - Support regional initiatives for developing common frameworks and methodology
    - Technology governance
    - Data governance
    - Standards governance

Recommendations

- Placement of Regional body within the structure of the political structure like the AU for AFREF.
- National Geodetic networks should as a first step be converted to the regional frame, e.g. AFREF
- A Global Reference Frame should be the goal using existing technology (and under development) to migrate to a Global Reference Frame

Food for thought for all of us

- Whitehead, 2012 has suggested different strategies for consideration
  - Scientific, commercial, Government (or a mix)
  - Sparse Density vs optimal Density
  - Static (Passive) vs Dynamic (Real Time)
  - Progression Plan –Evolution of technology

Conclusion

LBS realises its full potential and value [illegible] anchored on a shared comm[illegible] ITRF, and internati[illegible]y a[illegible]

A Common Fra[illegible]d sta[illegible] provide [illegible] co[illegible]eration and co[illegible]ati[illegible]a[illegible]plifies the impact of co[illegible]

Thank you