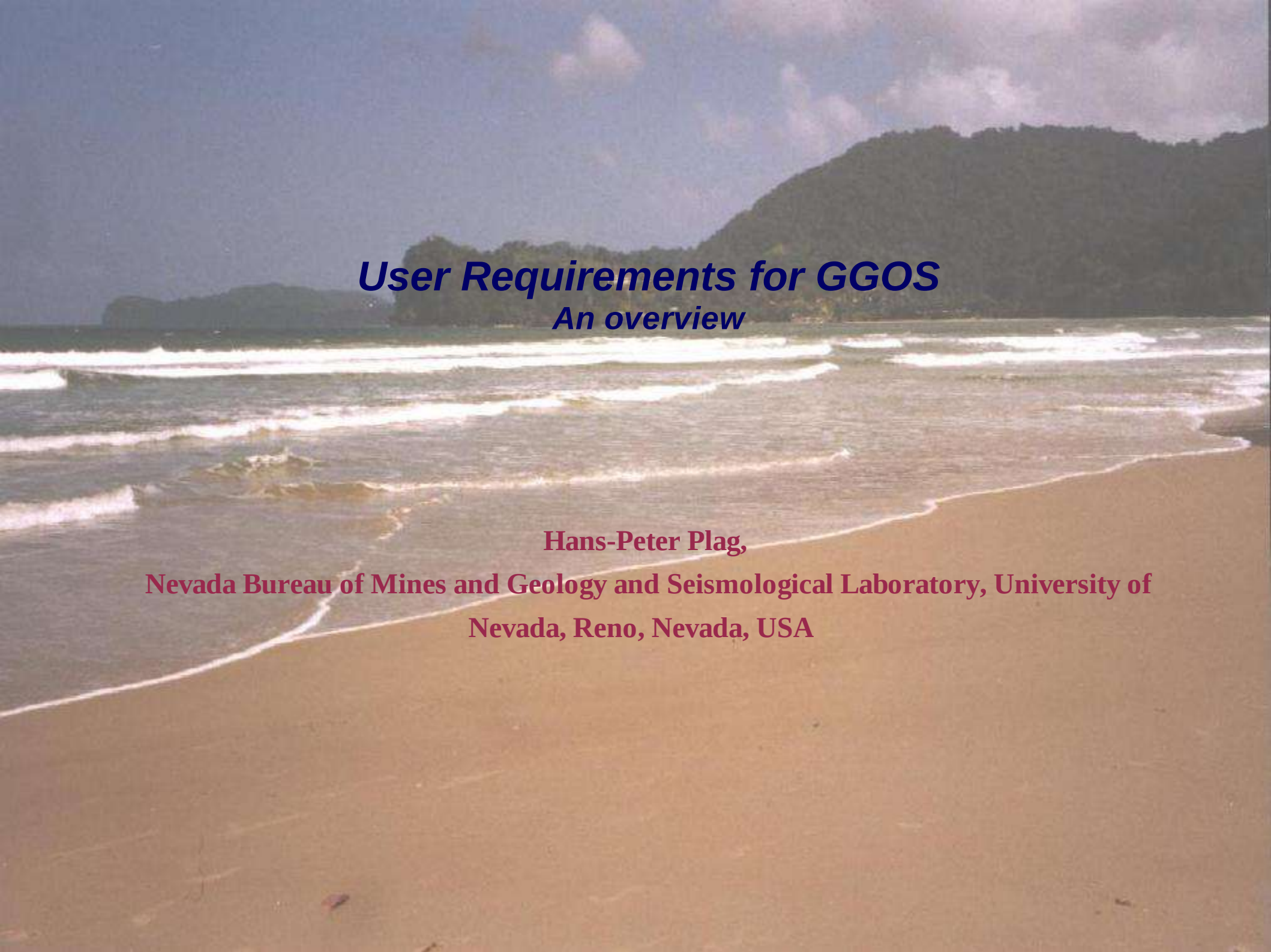


User Requirements for GGOS

An overview

Hans-Peter Plag,

Nevada Bureau of Mines and Geology and Seismological Laboratory, University of Nevada, Reno, Nevada, USA

Overview

User Interfaces and existing User Requirement databases

- GEOSS: A System Ordered and Owned by the Users
- GEO User Requirements
- CEOS/WMO Database of User Requirements and System Characteristics

User groups and Requirements

- Relevant studies (Canada, Norway, INDIGO, GAGOS)
- GGOS User groups
- GGOS User Requirements

User Requirements: A Tool for System Planning for GGOS?

- A User Requirement and System Performance Database
- A proposal for a GGOS User Interface

GEOSS: A System Ordered by the Users

2002: World Summit on Sustainable Development in Johannesburg, South Africa:

Urgent need for coordinated observations relating to the state of the Earth

June 2003: G8 Meeting in Evian

affirmed importance of Earth Observations

July 2003: First Earth Observation Summit (EOS-I) in Washington, DC: 33 Countries+EC and 21 international Organisations:

- Established the ad hoc Intergovernm. Group on Earth Observations (ad hoc GEO)

- Task of ad hoc GEO: initial 10 year Implementation Plan by February 2005

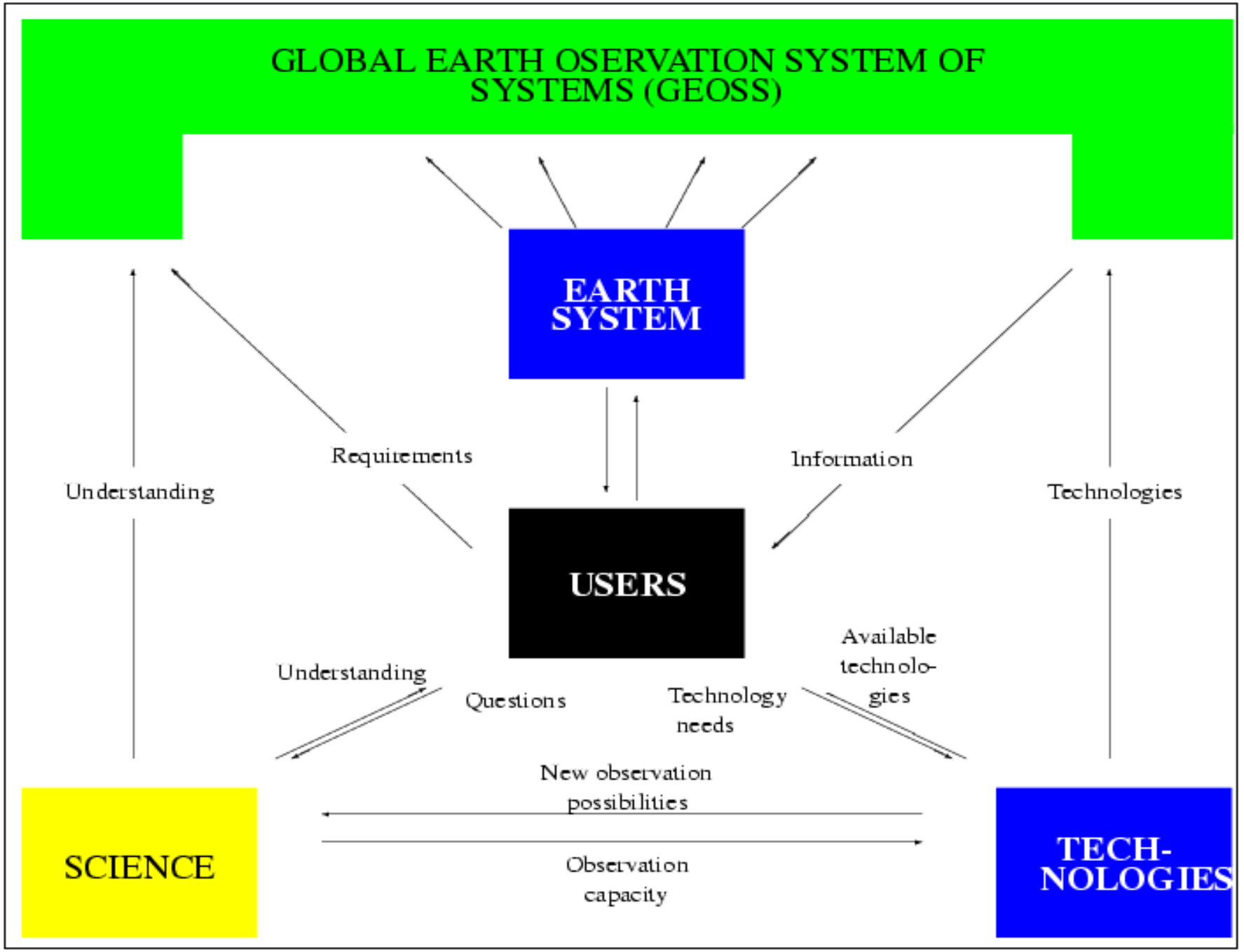
April 2004: EOS-II in Tokyo, 43 Countries + EC plus 25 international organisations:

- Adoption of 'Framework Document': definition of nine benefit areas for Earth observations

February 2005: EOS-III in Brussels:

- Adopts the 10 Year Implementation Plan for a Global Earth Observation System of Systems (GEOSS)
- Establishes the Group on Earth Observations (GEO) with the task to implement GEOSS

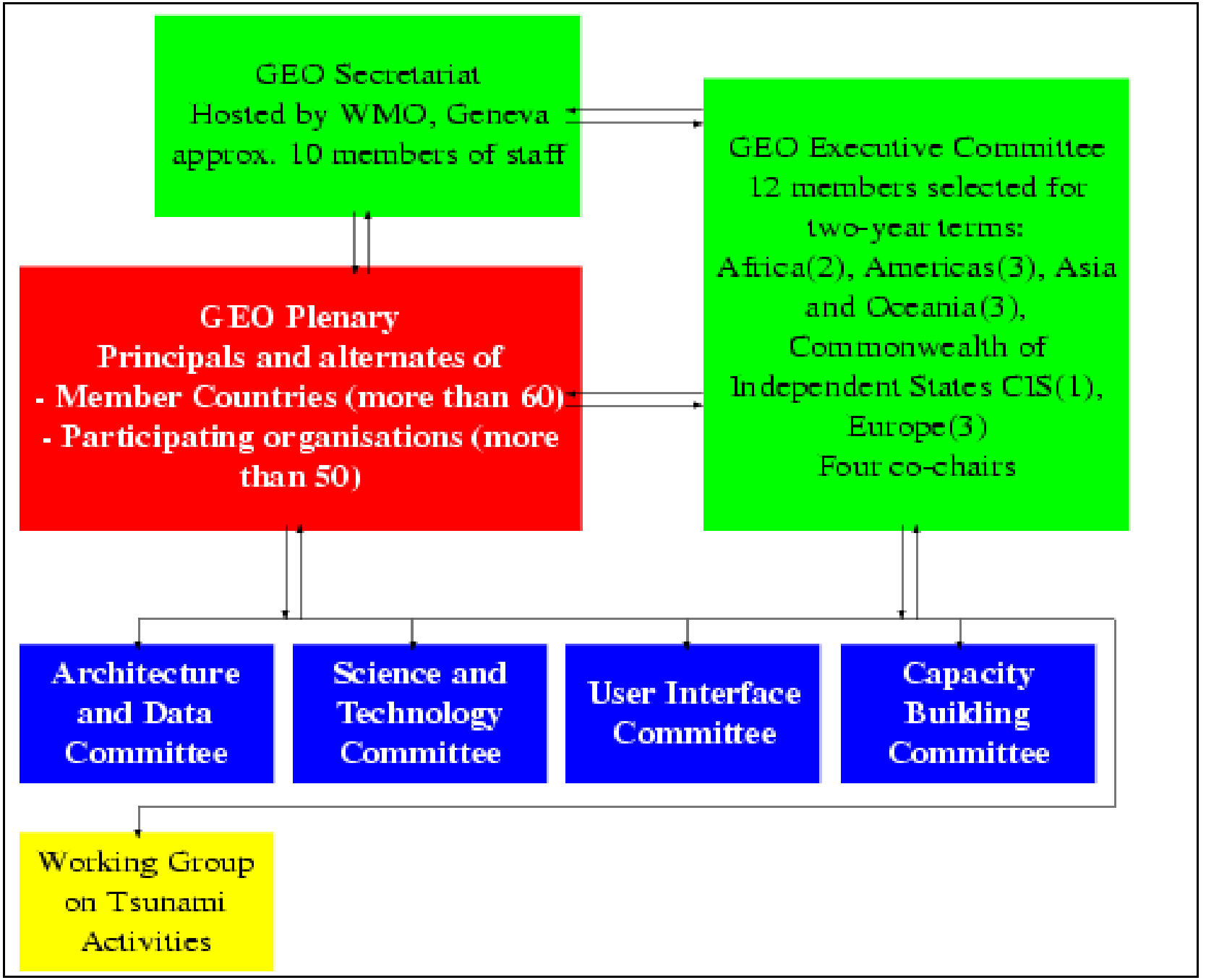
GEOSS: A System Ordered by the Users



GEOSS: A System Ordered by the Users

Vision for GEOSS is to realize a future wherein decisions and actions for the benefit of humankind are informed by coordinated, comprehensive, and sustained Earth observations and information

GEOSS: A System Ordered by the Users



User Interface Mechanism

Example: CoP Geohazards

- countries A/B (chairs)
- IGOS-P
- IEEE
- Countries ...
- IOC/UNESCO/ISDR
- Decision Makers

Example: CoP Health and Weather

- WMO (co-chair)
- ...

Example: CoP Health and Water

- country A
- UNEP
- FAO
- country B
- Decision Makers

GEO Ex Com

GEO Plenary Member States, Participating Organizations

GEO SEC

User Interface Committee

- **Representative of each Member/P.O.**
- **Representative CoPs**

Example CoP and linkages

Coordinate activities

CoP provides intelligence, expertise and input to GEO and respond to requests from GEO

GEO User Requirements

Second Earth Observation Summit (EOS-II) in Tokyo April 2004 identified nine Benefit Areas of Earth Observation:

- **Disaster**: reducing lost of life and property from natural and human-made disasters
- **Health**: understanding environmental factors affecting human health and well being
- **Energy resources**: improving management of energy resources
- **Climate**: understanding, assessing, predicting, mitigating, and adopting to climate variability and change
- **Water**: improving water resource management through better understanding of the water cycle
- **Weather**: improving weather information, forecasting, and warning
- **Ecosystems**: improving the management and protection of terrestrial, coastal, and marine ecosystems
- **Agriculture**: supporting sustainable agriculture and combating desertification
- **Biodiversity**: understanding, monitoring and conserving biodiversity

GEO User Requirements

Approach to User Requirements in the *ad hoc* GEO Phase:

- Subgroup on 'User requirements and Outreach' provided study with UR examples (in terms of spatial and temporal resolution, accuracy, latency, ...)
- Countries did UR studies (Canada, Netherlands, ...)
- URO SG and Writing Team prepared for each Benefit area a set of requirements in terms of quantities,
- assessed the current status of availability of observation

Recommendations in the GEOSS Reference Document:

- Establish and maintain a distinct and common user requirement database.
- Should be oriented on the CEOS/WMO database of user requirements and observation system capabilities.
- Database should provide a gap analysis mechanism.
- WMO experience in setting, reviewing and updating user requirements could be a basis: 'Rolling Review of Requirements' (RRR)

GEO User Requirements

Quantities related to geodesy included in GEO, 2005:

- Deformation monitoring, 3-D, over broad areas (3)
- Subsidence maps (3)
- Strain and creep monitoring, specific features or structures (2)
- Gravity, magnetic, electric fields - all scales (3)
- Gravity and magnetic field anomaly data (2/3)
- Groundwater level and pore pressure (4-1)
- Tides, coastal water levels (1)
- Sea level (2-1)
- Glacier and ice caps (2)
- Snow cover (2)
- Moisture content of atmosphere/water vapor (2)
- Extreme weather and climate event forecasts (3)
- Precipitation and soil moisture (3-1)

0: ok
1: marginally acceptable accuracy and resolution
2: could be ok within two years
3: could be available in six years
4. still in research

CEOS/WMO Online Database

http://alto-stratus.wmo.ch/sat/stations/SatSystem.html

Provides tables for:

- observational requirements,
- Space Agencies and Missions,
- Missions and Instruments,
- Instruments,
- Parameters measured by space-based and in-situ instruments,
- Instruments that measure a specific parameter.

Operational requirements for:

WMO, WCRP, GCOS, GOOS, GTOS, IGBP, ICSU, and UNEP.

Requirements in terms of:

- horizontal and vertical resolution (optimal and threshold),
- observation cycle,
- accuracy,
- delay,
- confidence,
- use

GGOS User Groups and Requirements

Several Surveys and Studies:

- Canada: Survey on Earth Observations
  Many users, quantitative interpretation difficult
- Canada: The Geodetic Reference Frame
  Between 7 to 10% of the National Gross Domestic Product depend on the geodetic reference frame
- Norway: National Geodetic Infrastructure: Present Status and Future Requirements

Contribution to global geodetic networks is fundamental for the national infrastructure

- USA: INDIGO
- Europe: GAGOS

GGOS User Groups and Requirements

The Challenge for GGOS:

- GGOS provides both relevant observations and a utility for Earth observation (in particular GEOSS) and other users.
- Users are often not aware of being users of geodetic products and services.
- Users are mostly not aware of their explicit requirements.
- IAG services and GGOS evolve in a mainly scientific environment (affiliation to IUGG and ICSU).
- ITRF an utility for Earth observation and other applications
- Observations relevant to many non-scientific applications

Current Situation

- **Reference frame:** User groups and user requirements fairly well known internally but far less externally
- **Earth system observations:** User groups less known, user requirements in the frame of GEOSS unclear, particularly for long-term observations

GGOS User Groups and Requirements

URs generally well documented

	Users	Geodesy's contribution
Earth observations & earth system models	Earth system scientists and modellers	Reference Frame and Observations
Data-to-Information archiving & services	Earth system service providers	IAG Services (not yet?)
Decision support tool development	Environmental process modellers & researchers	Provision of information, often through others
Decision making	Policy Makers & Environmental managers	Not aware of requirements
Assessment of benefits	Public officials, advocacy groups and the Public	Often not aware of geodesy

Less able to document needs

Modified from G. Foley

GGOS User Groups and Requirements

Here we distinguish three classes of users:

Earth Observation:

- Global Earth Observation System of Systems (GEOSS): Nine benefit areas
- Integrated Global Observing Strategy Partnership (IGOS-P): Several themes
- Non-geodetic applications (atmosphere, ionosphere)

Scientific users:

- geosciences
- global change and Earth system dynamics

Non-scientific users:

- many economic fields depend on
  - * stable, accessible reference frame
  - * easy access to positions
  - * increasingly monitoring of processes

GGOS User Groups and Requirements

UR: Science

Application	Parameter	Accuracy	S.R.	T.R.	Fr.	R.
Mantle convection and plate tectonics	3-d velocities	< 1 mm/yr	n/a	n/a	G	several decades
	static geoid	$< 10^{-9}$	n/a	n/a	G	and longer
	secular strain rate	10^{-15} s^{-1}	10^3 km	n/a	G	
Postglacial rebound	3-d velocities	< 1 mm/yr	10^2 km	n/a	G	several decades
	geoid	$< 10^{-9}$	n/a	n/a	G	and longer
	strain rates	10^{-15} s^{-1}	10^2 km	n/a	G	
	Earth rotation	0.1 mas/yr	n/a	n/a	G	
	local sea level	< 1 mm/yr	2 to $10 \cdot 10^2$ km	n/a	G	
Climate change, including present changes in ice sheets and sea level	3-d displacements	1 mm	10^2 km	months	G	decades
	3-d velocities	< 1 mm/yr	$< 10^2$ km	n/a	G	decades
	local gravity	< 0.3 μGal	$< 10^2$ km	n/a	L	decades
	geoid	< 10 mm	200 km	n/a	G	decades
	Earth rotation	0.1 mas/yr				
	local sea level	< 1 mm/yr	10^2 km	months	n/a	decades
Ocean circulation	gravity field	$< 10^{-9}$	10^2 km	months	G	decades
Hydrological cycle	gravity field	$< 10^{-9}$	10^2 km	months	G	decades
	3-d displacements	< 1 mm	10^2 km	months	G	decades
Seasonal variations	gravity field	$< 10^{-9}$	10^2 km	months	G	decades
	local gravity	< 1 μGal	n/a	months	L	decades
	3-d displacements	< 1 mm	10^2 km	months	G	decades
	Earth rotation	1 mas				
Atmospheric circulation	Earth rotation	1 mas		days		decades
Earth tides	gravity	0.01 μGal	10^3 km	hours	G	years
	3-d displacements	1 mm	10^3 km	hours	G	years
	strain	$^1 0^{-15}$ s^{-1}				
Surface loading	3-d displacements	< 1 mm	10^2	< 1 day	G	years
	local gravity	0.1 μGal				

Plag (2005)

GGOS User Groups and Requirements

UR: Science

Application	Parameter	Accuracy	S.R.	T.R.	Fr.	R.
Seismotectonics	3-d displacements strain	1 mm	$< 10^2$ km	days	G	hours to years
Volcanoes	3-d displacements gravity	1 mm 1 μgal	1 to 10^2 km			years
Earthquakes, tsunamis	3-d displacements local gravity earth rotation	1 mm to 1 cm 0.3 μGal	$< 10^2$ km	sec to days		

Plag (2005)

GGOS User Groups and Requirements

UR: Meteorological and climate applications

Nowcasting		
Requirement	Generic	GPS Meteorology network
Horizontal domain	Sub-regional	Europe to national
Horizontal sampling	5-50 km	10-100 km
Repetition cycle	0.25 - 1 h	5 min - 1 h
Absolute accuracy	1-5 kg/m^2	1-5 kg/m^2
Timeliness	0.25-0.5 h	5 -30 min

Numerical Weather Prediction				
Requirement	Generic		GPS Meteorology network	
Horizontal domain	Global	Regional	Global	Regional
Horizontal sampling	50-500 km	10-250 km	50-300 km	30-100 km
Repetition cycle	1-12 h	0.5-12 h	0.5-2.0 h	0.25-1.0 h
Integration time			MIN(0.5 h, rep cycle)	MIN(0.25 h, rep. cycle)
Absolute accuracy	1-5 kg/m^2	1-5 kg/m^2	3-10 mm	3-10 mm
Timeliness	1-4 h	0.5-2 h	1-2 h	0.5-1.5 h

Climate Monitoring		
Requirement	Generic	GPS Meteorology network
Horizontal domain	regional-global	All
Horizontal sampling	10-100 km	10-250 km; indiv. stat.
Time domain	>> 10 years	Weeks to many years
Repetition cycle	1 h	1 h
Absolute accuracy	0.25-2.5 kg/m^2	1 kg/m^2
Long-term stability	0.02-0.06 kg/m^2/decade	0.04-0.06 kg/m^2/decade
Timeliness	3-12 h	1-2 months

Elgered et al. (2004)

GGOS User Groups and Requirements

URs: Overview for Geometry

Application	Parameter	Accuracy	Latency	Fr.	Repro.
Surveying with PPP	3-d coor.	10 to 50 mm	days	N	decades
	velocity	1 mm/yr	n/a		
Monitoring	3-d coor	< 10 mm	days	L	decades
	velocity	< 10 mm/yr	weeks	L	decades
Control of processes	horizontal	10 to 100 mm	seconds to minutes	L	decades
Construction	3-d	< 10 mm	seconds to minutes	L	months to years
Numerical weather prediction	IPWV	1-5 kg/m^2	5-30 minutes	G	decades
Climate variations	IPWV	1 kg/m^2	1-2 months	G	decades
Scientific studies	3-d coor.	< 10 mm	n/a	G	decades
	velocity	< 1 mm/yr	n/a	G	decades
Earth observations	3-d coor.	10 mm	days	G	decades
	velocity	1 mm/yr	n/a	G	decades

Plag (2005)

GGOS User Groups and Requirements

URs: Geoid and Gravity field

Application	Accuracy Geoid (cm)	Accuracy Gravity (mGal)	Spatial Resolution half wavelength (km)
Oceanography:			
Short scale	1-2		100 km
	0.2		200 km
Basin scale	~ 0.1		1000 km
Solid Earth:			
Lithosphere and upper mantle density structure		1-2	100 km
Continental lithosphere			
– Sedimentary basins		1-2	50-100 km
– Rifts		1-2	20-100 km
– Tectonic motions		1-2	100-500 km
– Seismic hazards		1.0	100 km
Ocean lithosphere and interactions with asthenosphere		0.5 - 1.0	100-200 km
Geodesy:			
Levelling by GPS	1.0		100-1000 km
Unification of worldwide height systems	1.0		100-20000 km
Inertial navigation system		~ 1-5	100-1000 km
Orbits (1 cm radial orbit error for altimetric satellites)		~ 1-3	100-1000 km
Ice sheets:			
Rock basement		1-5	50-100 km
Ice vertical movements	2.0		100-1000 km
Sea-level change:	Many of the above applications, with their specific requirements, are relevant to sea-level studies 5		

Drinkwater et al. (2003)

User Requirements: A Tool for System Planning for GGOS

Vision:

Improve the Geodetic Observing System for the benefit of society.

Can the comparison of user requirements and system performance guide the improvement of the observing system and help to identify system gaps?

A User Requirement and System Performance Database

User Requirements:

- Applications
- Users
- Requirements
- Links of User to Applications
- Links of Applications to Requirements

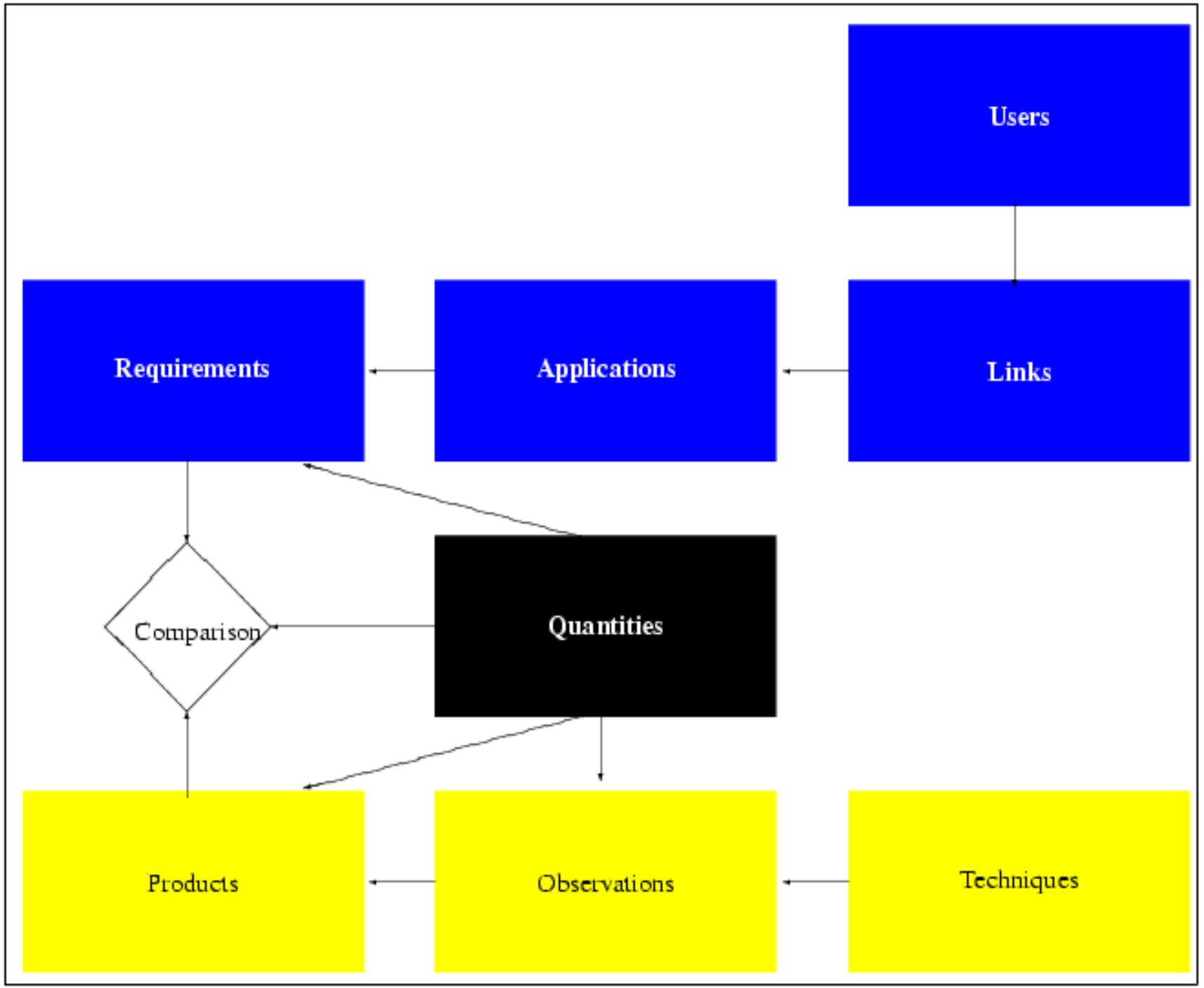
System Performance:

- Observations
- Products
- Techniques

Link:

- Quantities and products

A User Requirement and System Performance Database



A User Requirement and System Performance Database

A GGOS approach to fill the tables:

- Science based approach, looking from GGOS (via GEOSS?) to the users' needs in the benefit areas identified by EOS/GEO.
- Considering the need for comprehensive monitoring, the spatial and temporal characteristics of the quantities determine the necessary monitoring system.
- GEO User Interface Committee and Communities of Practice
- GGOS WG: '*User linkage and Outreach*': Contact to user groups.
- IAG services for the system performance part

What are the lessons learned from

- EC funded project '*Assessing and forward planning of the Geodetic and Geohazard Observing Systems for GMES applications*' (GAGOS)
- U.S. Project INDIGO?

GGOS User Interface

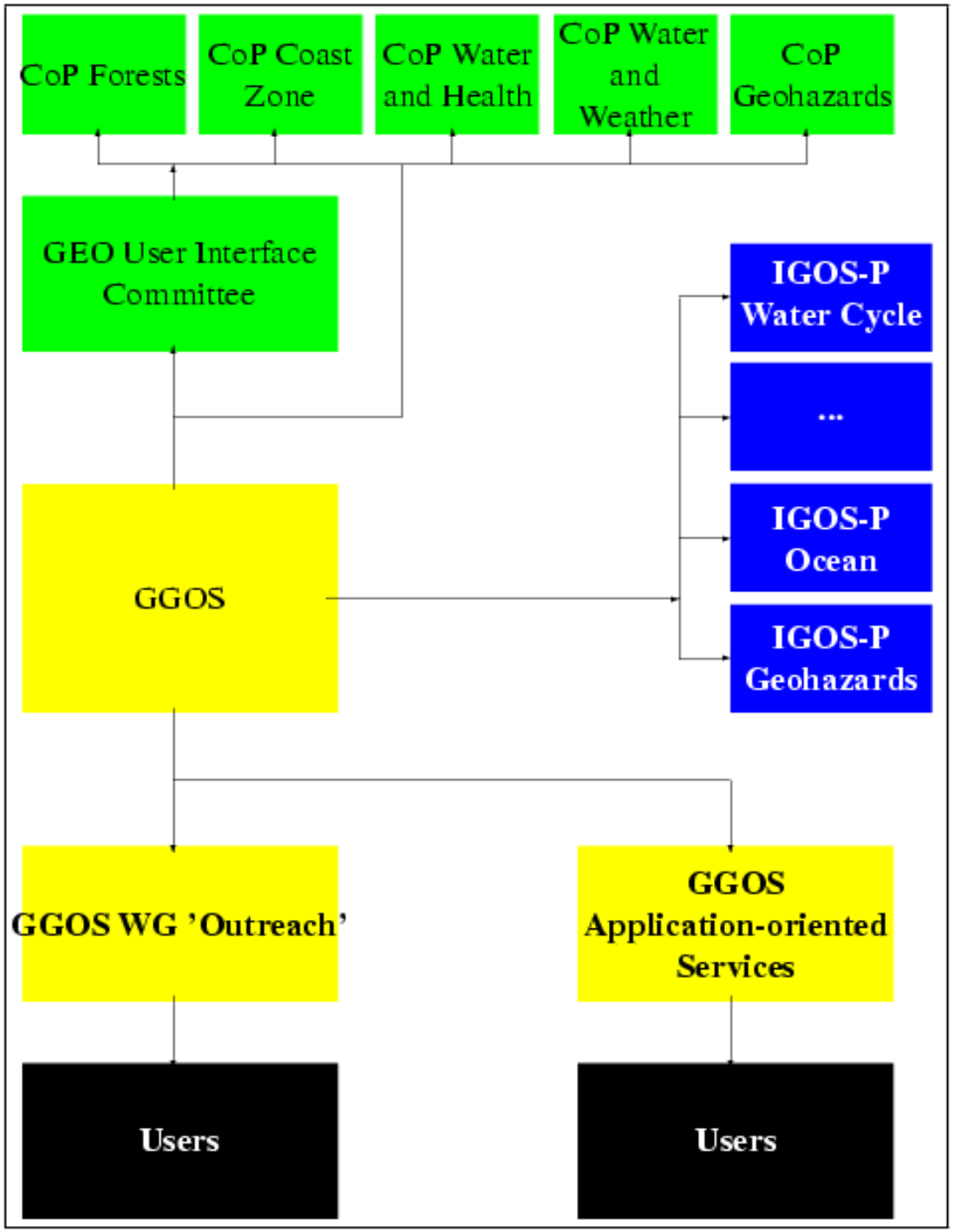
Goal of the user interface:

Enable GGOS to have contact to a broad range of users and to understand their requirements.

Potential elements of the user interface:

- Participation in IGOS-P Themes
- Representation in GEO Committee for User Interface
- Participation in relevant Communities of Practice
- GGOS WG Outreach
- Application-oriented services

GGOS User Interface



Question for Retreat

Should GGOS establish a user requirement and system performance Database as a tool for system planning and assessment?