GWIC 3G Governance Subcommittee Draft Recommendations

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Quote From “Ultimate Goals” Section

- “The construction of a global network of detectors is the cornerstone to scientific success for 3rd generation gravitational wave detectors. Moreover, if carried out with a vision to the future, the third generation implementation, in its infrastructure, technology base and governance can provide the point of departure for subsequent developments beyond the third generation, a path to the long and revolutionary future of gravitational wave astrophysics.”

From my DAWN III talk **(but amended)**

Options for Global Project Governance

- Intergovernmental (treaty) organization (strongest)
- International Research Infrastructure Consortium (added)
- International partnership of existing executive organizations via legal member corporation
- International collaboration of existing executives via single nonbinding member association
- International collaboration with multiple nonbinding agreements with multiple existing executive organizations
- International coordination of separate, but related, existing executive organizations
- Non-coordinated separate, but related, existing executive organizations (least strong)

Starting Points/Initial Conditions

- 2G: LIGO, Virgo, KAGRA, LIGO-India in motion
  - A powerful ad hoc global network
- LIGO and Virgo function in an MOU-driven collaboration, mostly on data analysis
  - KAGRA will collaborate as well
  - LIGO-India will ultimately join this network
- Upgrades to these 2G systems are planned
- Pre-conceptual work has begun on candidate regionally envisioned 3G designs
  - ET has been under development for some time as European candidate
- GWIC, GWAC, APIF, ApPEC, ApPIC, GSO and others are playing initial roles considering the future
- We felt that our deliberations should be informed by these starting points, but not constrained by them

Driving Thoughts in Our Deliberations

- What is the best path for the long future, including beyond 3G?
  - Pre 3G - Role of existing observatories or arrangements
  - Post 3G - Next "first step" may set the field on the best path for the long future
- 3G will require several nodes in the billion dollar/euro class
  - These add to an investment of CERN LHC scale
  - There are very few such capital investments in basic science
- How do we convince the sponsors (funding agencies) that we are setting out with the right plan and arrangement for managing great financial, political, social and technical risk?
  - The current or initial plan may be revised significantly once detailed non-advocate technical, cost and schedule reviews are carried out
  - The community/proponents and the sponsors must develop a collaborative partnership

Science/Technical/Requirements

- Our Governance draft report was first drafted without much input from the science, R&D and other GWIC subcommittee deliberations
- These separate efforts must inform each other and result in a set of coherent reports
- We assume a minimum of 3 3G detector sites
  - USA, Europe, Asia, Southern hemisphere,…?
  - One design or varied designs?
- Unity of the science case is a most important driver

Governance <--> Successful Global Proposals

- 3G detectors/sites will be billion dollar/euro class investments
- As 3 or more are needed this leads to 3G as a CERN LHC/SKA/ITER class investment for the sponsors
  - With corresponding long term operating costs
- Strong planning, management, control of risks is needed to assure confidence of sponsors/agencies
  - This argues against ad hoc heterogeneous 3G implementations

How to get to the envisioned governance?

- Though we work from prior models, one size does not fit all
  - 3G GW will be a unique global scientific enterprise and community
- Needed:
  - Community road mapping
  - R&D, generic → design specific → precursor efforts
  - Funding agency engagement, consensus and confidence
  - Science/technical lifestyle in the transitional and final organizations
- Phased approach has been used by other global projects

Recommended 3 Models for Consideration: #3 (not in priority order)

- *International non-profit member company such as a Delaware LLC, German GmbH, etc.*
- Companies of this type are fully recognized internationally.
- Governments can be members of the corporation
- Can make written company formation documents and contribution agreements that are legally binding and internationally recognized.
- Can have independent and appropriate procurement and employment systems and are fully responsible for all financial matters.
- Privileges and immunities enjoyed by the two international structures described following can be bestowed upon an international company by voluntary agreements with host countries as has been done in several cases in Chile and Spain.

Recommended 3 Models for Consideration: #2 (not in priority order)

- *An international research infrastructure consortium similar to the European Research Infrastructure Consortium (ERIC) model in which each European partner deposits a letter of commitment to the agreed work of the consortium, signed by an appropriate government official.*
- In this European model, the deposited commitment letters and research infrastructure agreement documents are deposited with the European Commission. The commitments are voluntary by each government and can be changed by depositing a revised commitment letter.
- Carrying many of the features and strengths of an IGO, this structure is less challenging to implement.
- Since the gravitational network considered here extends beyond a European perspective, we assume that a mechanism to implement an ERIC-style structure in a broader international context can be implemented, by depositing the agreements in a broader international repository. We call this an International Research Infrastructure Consortium (IRIC).

Recommended 3 Models for Consideration: #1 (not in priority order)

- *An <u>Intergovernmental Organization based upon a treaty-strength international Convention</u> as exemplified by CERN or the emerging SKA IGO.*
- In this model, governments sign the fixed Convention in a very durable, powerful and inflexible commitment.

Phasing

- Three recommended final governance models are all strong models
  - The eventual final arrangement must be agreed to by the funding agencies who become the members of the formed entity
- These are generic models and developing the right final governance has been shown to be an iterative phased process involving all levels from agencies at the top to scientific/technical workers at bottom of organizational pyramid
- Phased process has to strongly support scientific/technical/political/social/project development at each progressive phase
- Each phase has to enable and lead naturally to the next successive phase

Phase 1: Current Collaborative Phase

- As an initial transitional step, the current collaborations, possibly through GWIC but almost certainly requiring significant funding agency guidance and mandate, promptly forms a collaborative non-legal "company", governed by a collaborative board that guides actions by the legal sponsor/implementing agencies, to define a program of collaborative research and development, and design studies that progresses beyond the current ET and CE concepts. The ET and CE R&D efforts should focus on developing technical feasibilities of selected technologies, and should evolve into exploring suitability for a broad range of sites.
- The company should develop:
  a. A detailed science case document, including multi-messenger topics.
  b. An international collaboration on R&D and civil infrastructure issues: mirrors, coating, quantum and cryogenic technologies, vacuum technologies, environmental monitoring and control, civil infrastructure technologies (e.g. excavation) …
  c. A common framework to tackle the computing issues, including low latency and alert distribution.
  d. A common engaged roadmap from the current generation from 2G to 3G.
  e. Governance documents for the next phase together with involved funding agencies.

Phase 1: Collaborative Phase continued

- In addition, it would coordinate
  a. Science and technical requirements for a third generation array of detectors.
  b. Detector architectures including the level of design homogeneity that can be achieved in order to simplify the implementation, taking into account local conditions.
  c. Cost studies for site infrastructure and detector architectures and identification of value engineering priorities and cost cap targets.
- Ideally, this program can be accomplished in 2 years from agreement to proceed recognizing that GWIC has already initiated some of the early stages of this process. After this 2 year period, one would expect:
  a. a complete science case document for the 3G array;
  b. unique or coordinated solutions for the interferometer technologies and infrastructures, including computing ;
  c. a series of CDRs or TDRs on regional or global implementations, depending on the maturity of different regional initiatives, including site selection documentation and eventual choices;
  d. conceptual or detailed cost estimates and schedule definition;
  e. corporate documents as proposals for the next governance phase of coordination.
- It should give way as rapidly as possible to the next type of organization, described below, that will continue the work above.

Phase 2: Legal international company phase

- A fully legal international company is formed as defined in the corporate documents drafted in the previous phase. This organization will be a member corporation with each of the sponsors/funding agencies providing representatives to serve on the governing board. This company will manage the developing project for the members who will pledge to contribute needed in-kind and cash resources to this phase. The principle task in this phase is to do all work needed to bring the third generation project to construction readiness. During this phase, the baseline interferometers will reach final design, fabrication readiness, cost/schedule baselining and all needed elements of project definition. Interferometer and headquarters sites will be selected though all sites may not be equally ready for deployment and environmental impact processes may extend this step. Operations plans and costs will be defined at the conceptual level.

- This phase should aim to be completed in a maximum of 6 years.

Phase 3: Final Governance Phase

- The final legal international company, or IRIC or IGO, will be formed and first commitments to initiate construction will commence. This organization will manage the construction, transition to operations and will manage the operating observatory system.

Advantages of a staged progression

1) It immediately provides a coordinated framework for R&D, infrastructure and computing solutions from the start, defining this task as a global issue. This is certainly a first with respect to previous history.
2) It takes into account the different regional rhythms of transition, or funding opportunities, facilitating the progression of the GW field into a true global effort.
3) It provides a solution for the diversity of members, since there are different organizational structures in every country. Even current consortia running 2G detectors, or other regional entities (e.g. ERIC) could eventually participate as separate entities. Other international organizations with common interests in R&D and infrastructure could also participate as full or associated members.

Timescale

- The progression described above brings the project to the construction stage in 6-8 years from initiation. This process may well take longer than 8 years given the complexity of the technical, political and social goals.
- However, if construction on the first couple of interferometer sites commences in 6-8 years and requires another 6- 8 years until first lock at these sites, based upon the initial LIGO (1994-2001) and Virgo (1997-2003) experience, the third generation will arrive in about 15-16 years from a decision to initiate this phased progression.
- The current LIGO and Virgo interferometers, with envisioned running and upgrades should be in their final epoch at 15 years from now. Thus, the suggested timescales are appropriate goals for smooth growth of this exciting field.

Next Steps

- DAWN V will discuss forming an Umbrella Organization
  - Is the Umbrella self-appointed or is there some mandate/authority from the funding agencies?
- Can we apply this governance report framework to the Umbrella?
- How can the community and funding agencies coordinate this?
- Given the high costs of 3G nodes, how can we avoid funding agency surprise when mature proposals appear?

DAWN III slides as backup

Bottom Up and Top Down Analyses of Governance Models

- Charge - "By applying knowledge of the diverse structures of the global GW community, propose a sustainable governance model for the management of detector construction and joint working, to support planning of 3rd generation observatorieS"
  - Key **visions** are hinted at in this charge
- Subcommittee is considering studying many existing or past governance examples of diverse science megaprojects and subjecting them to SWOT analysis.
  - SWOT results would then be compared to what subcommittee feels the right solutions are for the global 3rd generation GW community
- This is a good process
- It is bottom up – analyze examples and compare with subcommittee's vision and heuristic sense of appropriate features
- In these slides, I attempt to display a top down view of the same problem
  - Not as an alternate approach
  - As a way to understand the landscape in a general sense
  - To help locate the analyzed examples in this landscape
  - To point out that the models have to match your **vision** going forward

The Top Down Landscape of Governance Models

- The models I will describe are the basis vectors of a space of governance models
  - …approximately…the models are idealized
- However, they map onto the space that contains the possible scientific, cultural, technical and competitive/cooperative visions that you have
  - Who are you and what is the 3rd generation…?

Phases of a megaproject

- Conceptual
- Development
- Construction
- Operations
- Decommissioning and Restoration

- Begin discussion by considering governance for Construction and Operations phases
- Earlier phases can be governed by same models or by transitional arrangements to be discussed

Starting Points – Originator structure drives governance

- Existing intergovernmental organization as host and originator
  - Community organized by originator
- Existing major national laboratory as host and originator
  - Community or collaborations organized by originator
- International funding agencies as originators via funding agency peer consultation
  - Each funding agency organizes its supported community
  - Funding agencies guide their communities into collaboration
- Peer to peer university and laboratory originators via collaboration
  - Collaboration forms and then approaches respective funding agencies or existing intergovernmental or national laboratories
- Multiple national laboratories or institutes originate
  - Coordination of parallel related efforts,
  - collaboration on unified effort
  - or joint project with unified management

<u>Deliverables</u> drive governance

- Single major instrument at single site
  - Determined site ?
  - Site to be determined ?
- Single or multiple instruments at multiple sites
  - Determined sites ?
  - Sites to be determined ?
  - Homogeneity or diversity of instrumentation ?
- Instrumentation to be delivered in succeeding phases
  - Is this a <u>one time vision</u> of governance or is it the first step in a <u>long path through the future</u>
    - LIGO 1, LIGO 2 – just two steps
    - CERN formed in the same yearning for a long peaceful future that started the European Union
    - Should we be talking about a single central global GW entity that endures?

Science Modes of Delivered Facility

- Delivers raw data products or delivers highly processed data products (promptly and publicly)
- Acts as service facility or is also a science participant
- Takes responsibility for delivered instrumentation or hosts instrumentation contributors who retain responsibility for delivered instrumentation
- Reviews proposed science or just hosts member utilization of their portions of science opportunity
- LIGO and Virgo have long ago transitioned from one science mode (builders do the science) to another (builders and non-builders do the science)

Starting Points – Driving/Retarding Conditions

- Supply chain or in-house technology
- Specific site allegiance or advocacy
- Specific design allegiance or advocacy
- Desire for industrial return
- Desire for lead role or preference for flat collaboration
- Nationalism, exceptionalism
- Globalism or regionalism

- Some of these lead to delayed or inefficient science
- Leadership is needed to resolve these issues and move the field forward

Options for Global Project Governance

- Intergovernmental (treaty) organization (strongest)
- International partnership of existing executive organizations via legal member corporation
- International collaboration of existing executives via single nonbinding member association
- International collaboration with multiple nonbinding agreements with multiple existing executive organizations
- International coordination of separate, but related, existing executive organizations
- Non-coordinated separate, but related, existing executive organizations (least strong)

Intergovernmental (treaty) organization (IGO)

- Governed by treaty
- Very powerful and stable over long periods of time
- Virtually assures that the scientific field will do well
- Stable funding stream by treaty though subject to sovereign funding availability
- Hierarchically matched – countries to countries
- Diplomatic immunities and privileges in host country and for staff of organization
- Bureaucratic and political
- Full top down control over staffing, procurement, financial policies
- Responsibility for tariffs, taxes, duties, and legal liabilities
- Procurements are political – “juste retour” of “noble work”
- Protective of privilege and status
- Examples – CERN, ESO, ITER, goal for SKA
- United States will not join such organizations as member
  - Will participate in other status

International partnership of existing executive organizations via legal member corporation

- True binding legal partnership if signed by financial authorities of members (funding agencies,…)
  - Except for limitation subject to sovereign funding availability
- Stable over long periods of time due to binding nature of agreements
- Several international corporate structures exist that can achieve this model with full international recognition (GmbH, Delaware LLC,…)
- Full control within corporation over staffing, procurement, financial policies as in a commercial corporation
- Full responsibility for tariffs, taxes, duties, and legal liabilities
- Members (funding agencies) can assign their performing organizations (national labs, institutes,…) to act for them in partnership
- Can even mix national governments and private Nongovernmental Organizations (NGO's) though this raises hierarchical issues
- Examples – TMT, current SKA preconstruction phase project

Single international collaboration of existing executives via single nonbinding member association

- Nonbinding agreement shifts performance burden towards “best effort by scientific collaborators”
- Financial contribution agreements are also best effort
- Less stable over long periods of time
- Preserves independence and “sovereignty” of collaborating executive organizations
- Requires existing executives to be fully responsible for legal actions such as hiring, contracting, tariffs, duties, intellectual property and liability
- Collaborating executives can assign their performing organizations (national labs, institutes,…) to act for them in partnership
- Can even mix national governments and private Nongovernmental Organizations (NGO’s) though this raises hierarchical issues
- Examples – ALMA

International collaboration with multiple nonbinding agreements with multiple existing executive organizations

- Nonbinding agreements shift performance burden towards “best effort by scientific collaborators”
- Financial contribution and in-kind contribution agreements are also best effort
- Less stable over long periods of time
- Preserves independence and “sovereignty” of collaborating executive organizations
- Requires existing executives to be fully responsible for legal actions such as hiring, contracting, tariffs, duties, intellectual property and liability
- Collaborating executives can assign their performing organizations (national labs, institutes,…) to act for them in partnership
- Can even mix national governments and private Nongovernmental Organizations (NGO’s) though this raises hierarchical issues
- Examples – Typical CERN or Fermilab high-energy physics collaborations

International coordination of separate, but related, existing executive organizations

- Similar to previous case though typical when different instrumentation or facilities are delivered and operated in a related and coordinated effort
- Example: LIGO, Virgo, LSC, VSC, GWIC

Non-coordinated separate, but related, existing executive organizations

- Examples: Underground laboratories such as Gran Sasso, Kamioka, SNO, US Sanford Lab
- (Advanced LIGO and Advanced Virgo) with KAGRA

Collaboration Parameters

- All contributions in cash to governing entity?
- Cash used for procurements in manner to provide "juste retour"
- Contributions divided between in-kind and common expense cash funds?
- Uniform policies across partnership?
- Contribution policies for conceptual, developmental, construction, operations, decommissioning and restoration phases?
- Scientific credit or equity tied to contributions?
- Voting percentage tied to contributions?
- Time value of contributions?
- Value basis for contributions rather than actual cost experience?
- Authority of central management?
- Governance, oversight vs. management authority?
- Management of poor performance by partners
- Consequential damages when one partner prevents performance by another
- Policy for addressing cost growth
- Policies on partner default
- Default and authorship and termination of access to data
- Withdrawal policies
- …

What is your vision for 3rd Generation GW or for a longer future

- Single world GW laboratory with multiple sites
  - Vision extends beyond 3rd generation
- Vision of 3rd generation only
- Coordination or unified management of technology development
- Only one 3rd generation IFO design deployed at multiple sites
  - One construction project
- Diverse designs deployed at different sites but coordinated in operation and production of science
  - Construction managed separately
  - …
- Is the starting point of opening the field of gravitational wave astrophysics established by the current generation or is the 3rd generation when that threshold will be realized or …
- These overwhelmingly influence the proposed governance model
- Who are you and what do you want to be?

Phases: One Example

- Conceptual
- Development
- Construction
- Operations
- Decommissioning and Restoration

- SKA has had the first two phases and is preparing the third phase
  - PrepSKA – conceptual design and technology development
    - Precursor arrays of antennas built and operated for astronomy as working full science prototypes in different countries with different designs
    - Governed as loose association and guided by top down funding agency consultations
  - Preconstruction phase – preparing for construction readiness, a legal member international corporation was set up and is coordinating design efforts funded by cash contributions from partners and disbursed as funded work packages to member executing organizations
    - IGO is being designed for construction phase
  - Construction and Operations phases will be executed by IGO as if it were CERN or ESO

Things To Consider

- Vision of future
- One step or a path
- Starting point
- Nature of originators
- Appropriate models
- Collaboration parameters
- Phase progression

- Decide the leading options in your vision? Then the governance follows.