



# Forwards Together: IGIF-MSDI Maturity Roadmap

“Quick-Start Guide for undertaking an IGIF-aligned MSDI”  
May 2022: Version 1.0 – Revision 0

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Cooperatively supporting the IGIF-MSDI Maturity Roadmap initiative ...



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# Executive Summary

[Draft and insert after the Main Content is complete and approved by the Contributors Panel ...]

## Six-Point Summary of the IGIF-MSDI Maturity Roadmap

Who?		For Hydrographic Offices (or national equivalents)	
Why?		Intra and cross-agency engagement is key to success	
What?		Alignment of an MSDI implementation with the IGIF	
When?		Pre-implementation to early and middle stages	
Where?		As a stepping-stone to the full IGIF-MSDI ecosystem	
How?		Early alignment will reduce future costs of divergence	

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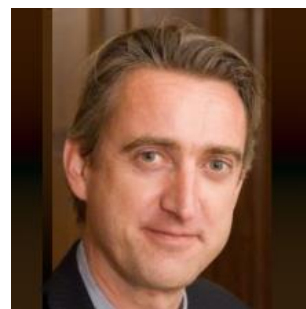
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## Introduction to this IGIF-MSDI Maturity Roadmap

### Who is this intended for?

This IGIF-MSDI Maturity Roadmap is intended to provide guidance for those within Governmental departments or agencies, who are actively planning an MSDI (Marine Spatial Data Infrastructure) implementation, which is aligned with the broader IGIF (Integrated Geospatial Information Framework) developed by the United Nations. Such stakeholders are typically found within hydrographic offices or equivalent governing body, though this is not exclusive and will likely vary depending on the national arrangements within a country.

### Why it is useful?

For national agencies beginning their IGIF-MSDI journey, this roadmap can assist in circumstances where familiarity is not at a level sufficient for enabling a hydrographic office (or national equivalent) to pursue an IGIF-MSDI transformation programme. Depending on the arrangements within a country, increased engagement may be needed at the agency leadership level (delegated marine responsibilities), between governing agencies (split responsibilities) or at an Executive branch level (centralised responsibilities). This roadmap can be particularly useful as an executive summary, where full exposure to the ecosystem of separate IGIF and MSDI resources might create more questions than answers from decision-makers.

### What is covered here?

This roadmap aims to cover the essential elements needed for an effective MSDI implementation, which is both aligned with and supportive of the United Nation's IGIF initiative. It aims to distil IGIF-MSDI topics into a more digestible "quick-start" guide or "menu of options". As such, it is not intended to be complete, comprehensive or to replace any existing resource from either the IGIF or MSDI communities of interest – only to synergise and complement them.

### When is it ideally applied?

Although it can be usefully applied at any point in development of an IGIF-compliant MSDI journey, it is especially well suited to nations who are beginning or have recently started their IGIF-MSDI journey. It is designed to align with government modernisation agendas, digital transformation, climate change and blue economy initiatives, helping to maximise the benefits of such undertakings. For hydrographic or maritime agencies having already started an IGIF and/or MSDI implementation, this Maturity Roadmap can help to show that current undertakings are adopting IGIF-MSDI global Best Practice.

### Where is it applicable?

This IGIF-MSDI Maturity Roadmap is most applicable within hydrographic and marine geospatial agencies of national governments. It is especially suited where a relatively prescriptive "stepping-stone" is desired towards the current ecosystem of IGIF and MSDI resources. These include extensive published materials hosted by the UN or IHO (excluding industry, academic, or national-level resources), which provide the framework for aspiring nations undertaking an IGIF or MSDI initiative respectively. This joint roadmap is designed to complement and support any existing resources, where stakeholders should eventually progress onto using these in-depth resources, as/when they consider it appropriate to do so.

## How will it help?

This IGIF-MSDI Maturity Roadmap is intended to enable early alignment of an MSDI implementation with the UN IGIF Nine Pathways, thus reducing the risk of later divergence that would take significantly more effort and financial cost to correct (than that needed for early alignment). This is especially the case for mission critical technologies that have been implemented and effectively hardwired into an organisation, but that are not interoperable with end-users, data suppliers, stakeholders or MSDI partner agencies. One key benefit of early alignment is that a hydrographic office (or national equivalent) can remain relevant despite increasing competition from the private technology industry and open sources of data, which are not assured, verified, or validated for decision-making under time, safety, or security critical conditions. The following diagram provides some key examples of IGIF-aligned MSDI contributions [\[Consult w/ AC\]](#).



Figure 1: IGIF-MSDI contributions to Marine Spatial Planning, National SDI, wider Governmental decision-making, plus socioeconomic activities by individuals, businesses, and industry sectors. [\[Update with NSDI connections to National Strategy and Intergovernmental link to the World Bank ...\]](#)

## What is the IGIF and an MSDI?

### UN Integrated Geospatial Information Framework (IGIF)

[Leverage the widely accepted preface used in WB documents ...]

Developed and first released via the United Nations Statistics Division in 2018, the [Integrated Geospatial Information Framework](#) (IGIF) provides countries with a basis for developing, integrating, strengthening, and benefiting from geospatial information management. It will assist countries in bridging the geospatial digital divide and to secure socio-economic prosperity for all sectors of civil society.

The IGIF encompasses three connected documents: Part 1 is an [Overarching Strategic Framework](#); Part 2 is an [Implementation Guide](#); and Part 3 is a Country-level Action Plan (specific to a nation's goals). These three parts comprise a comprehensive framework that serve a nation's needs in addressing economic, social, and environmental factors, which depend upon location information that can be fast-changing.

The Implementation Guide describes what is needed to establish, maintain, and/or strengthen a nation's geospatial information management system and capability. The IGIF focuses on location information that is integrated with other meaningful data, acting as a catalyst for economic growth and opportunity, whilst aligning with a nation's development priorities and the [UN Sustainable Development Goals](#).

Via a [collaborative agreement](#) between the UN and the World Bank, an SDI investment methodology referred to as the "Four Tools" was developed to standardised a financial approach to SDI development. The first tool is an *SDI Diagnostic Toolkit*, followed by *IGIF Alignment to Policy Drivers*, that leads to an *IGIF Socioeconomic Plan*, which ultimately results in an *IGIF Action Plan* at the Country-level. At all four stages, the World Bank's finance expertise ensures that all outputs are of investment-grade decision "quality".

The SDI Diagnostic Toolkit with its terrestrial origins and focus, is of key interest in this IGIF-MSDI Maturity Roadmap and is further developed with modular IHO and OGC input. This ensures interoperability with the original SDI model and hence an All-Domain NSDI approach (Air, Land, Sea, & Space). The analogy is the addition of "M" into (M)SDI with IHO insight and "Making it Real" with technology via OGC expertise.

The IGIF is sometimes referred to informally as the "Nine Pathways" that references the nine interrelated strategic pathways, which reflect the component parts of an integrated geospatial information system. It is key to note here that IGIF covers all types of geospatial information, not just the immediate context of marine data, building upon previous global efforts around National Spatial Data Infrastructures (NSDIs).

For completeness, IGIF has connections to other programmes that are also under the umbrella initiative of the [UN-GGIM](#) (UN Global Geospatial Information Management), which are developed and approved via the [UN Statistics Division](#). These resources include the [Implementation of Geospatial Standards](#) (via ISO, IHO and the OGC) and the [White Paper on \(Open\) Marine Geospatial Information](#) from the UN-GGIM [Working Group on Marine Geospatial Information](#) (WG-MGI).

Of note is the Operational Guide from WG-MGI, also known as IGIF-H ("H" for Hydro) that contributes thematically towards IGIF Country-level Action Plans around marine and hydrographic data. One useful analogy is that IGIF-H is an operational lens or filter through which to view IGIF proper in the context of hydrographic offices (or their national equivalents). **[\*\* Expand on IGIF-H when the draft is released \*\*]**



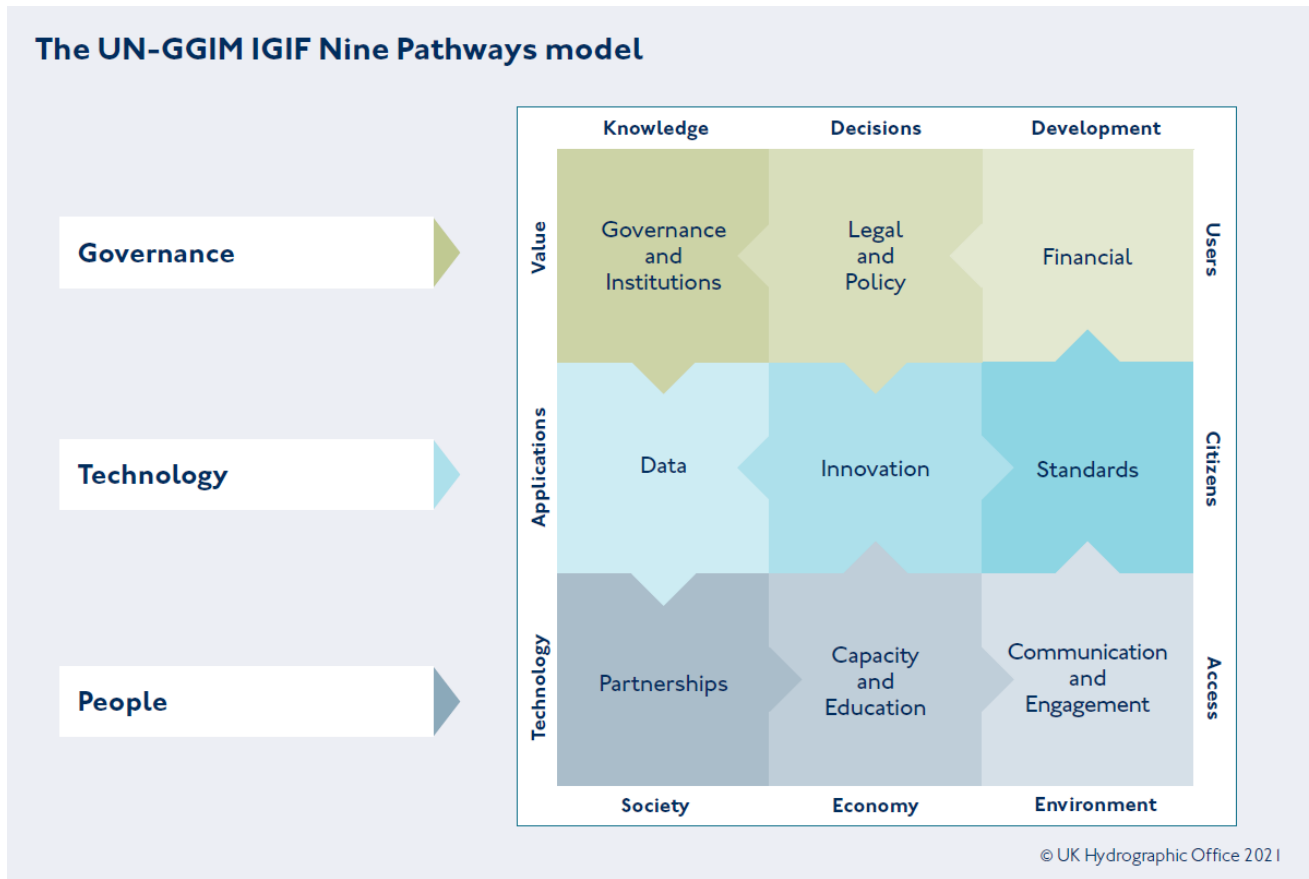


Figure 2: IGIF is anchored by nine strategic pathways and three main areas of influence. [Replace with the official UN graphics v2 if/when made available for open use]

## IHO Marine Spatial Data Infrastructure (MSDI)

The origins of the Marine Spatial Data Infrastructure (MSDI) concept can be traced back to the 2<sup>nd</sup> Edition (2005) of [IHO Publication M-2](#), now released in its 3<sup>rd</sup> Edition (2015). This paper outlines the benefits and options for the development of a national hydrographic policy that ensures national knowledge of the physical seabed and coast, as well as the currents, tides, and certain physical properties of the sea, such that the needs of safety of navigation and protection of the marine environment can be met. In 2009, the IHO set an objective for a definitive procedural guide in establishing the role of a national hydrographic authority in creating an MSDI, which will not only meet the requirements of the mariner, but that can yield additional and often greater socioeconomic benefits.

The Marine Spatial Data Infrastructure (MSDI) concept, as an essential component of a National Spatial Data Infrastructure (NSDI), is formally expressed in [Publication C-17](#) from the [International Hydrographic Organisation](#) (IHO). This publication provides official guidance to national hydrographic offices around the world for developing an enterprise MSDI capability, defined as *the relevant collection of governance, standards, technology, and content that facilitate the availability of and access to marine geospatial data*. An MSDI can be summarised or referenced using the Four Pillars model within Publication C-17, which was developed by the [IHO MSDI Working Group](#) (MSDIWG) with input from participating IHO Member States. As outlined within Publication C-17, the MSDI Four Pillars outline the People, Standards, Technology and Data required for sharing and analysing marine geospatial information across government and commerce. These areas describe the hardware, software, and system components necessary to support the structure of working practices and relationships across data producers and end-users for access to marine geodata.

The IHO-MSDIWG is a subsidiary body of the IHO [Inter-Regional Coordination Committee](#) (IRCC) tasked with supporting the MSDI and Marine Spatial Planning (MSP) activities of the IHO. The IHO-MSDIWG also hosts an online [Body of Knowledge](#) (BoK) as a resource for countries seeking to develop and implement an MSDI for their national requirements. This BoK contains a range of in-depth resources, including [MSDI training materials](#) (in-kind contribution from the Kingdom of Denmark) and a joint [MSDI Concept Development Study](#) between the IHO and the Open Geospatial Consortium (OGC). Other resources of note for include White Papers on [MSDI Capability Development](#) and [MSDI Benefits Realisation](#), alongside [Hydrographic Data Policy Best Practice](#) and [\(M\)SDI Frequently Asked Questions](#).



Figure 3: Visual summary of the MSDI Four Pillars, covering the key topics around marine geospatial data.

## How do the IGIF and an MSDI relate to each other?

Sharing parallels with the Global SDI Cookbook initiative from 2005, the first version of IHO Publication C-17 (now 2<sup>nd</sup> Edition) was formally released in 2009, whilst the IGIF Overarching Strategic Framework was published in mid-2018, both after a lengthy period of international collaboration and consultation. Although the MSDI concept predated IGIF at the time of first release, the latest iteration of C-17 now refers to the UN-GGIM and the importance of the IHO and its Member States as being “crucial to enabling the wider reach and use of hydrographic office data”. Separately developed, both methodologies are increasingly seen as synergistic, with the successful exploitation of marine geospatial data relying upon leveraging IGIF and MSDI together for meeting a nation’s objectives.

An imperfect but useful viewpoint is that **IGIF** offers a vision and strategy behind the “**Why**” of maximising geospatial information (of all types and domains) for inclusive socioeconomic benefit, whilst the **MSDI** concept provides the “**What**” regarding the operational areas for developing improved use of marine data. Also included within this wider concept is the “**How**” of technological interoperability using industry open standards, via the Open Geospatial Consortium (**OGC**) that will be covered in the following chapters.

As briefly covered in their respective introductions, both IGIF and MSDI have significant “ecosystems” of resources, which together encompass around 800 pages of published materials hosted by the UN or IHO. There also exists numerous commercial, academic, and national-level resources outside of these bodies. This combined wealth of commentary and insight, which although necessary for empowering nations to eventually chart their own IGIF-MSDI journey, can occasionally be an encumbrance for stakeholders new to an IGIF-aligned MSDI – especially when attempting to build consensus outside of their organisations.

It is however possible to leverage those elements between the two frameworks, which can synergise well in the context of acting as a “quick-start guide”, “menu of options” or “stepping-stone” towards full use of the IGIF and MSDI ecosystems of resources. This includes participation within UN and IHO groups that provide the opportunity to contribute and influence the future iterations of both geospatial frameworks. One area of synergy is a joint maturity roadmap that enables hydrographic offices to baseline their current readiness for an IGIF-aligned MSDI, plus the development opportunities available to them depending on their objectives and aspirations. Under regional collaboration initiatives, this joint IGIF-MSDI Maturity Roadmap as described in the following chapters, can contribute to more efficient allocation of resources between countries, for realising shared benefits that are overall greater than if undertaken independently.

# The Role of the OGC in IGIF and MSDI

## The Open Geospatial Consortium (OGC) and Open Standards

The [Open Geospatial Consortium](#) (OGC) is an international consortium of [more than 500](#) businesses, government agencies, research organizations, and universities motivated to make geospatial information and services FAIR – Findable, Accessible, Interoperable, and Reusable. The [OGC approach](#) focusses upon the collaborative and agile development of consensus-based open standards, innovation projects, and partnership building amongst OGC members and other liked-minded groups (such as the UN and IHO).

Open standards support UN and IHO goals by promoting equal access to geospatial benefits for users of open source and proprietary systems, reducing the digital divide with regards to national development. Interoperability avoids “vendor lock-in” to a specific piece of technology or supplier community, thus reducing through-life costs for digital services via increased competition and the reuse of components. Open standards give better protection for datasets created on applications that implement them, which is crucial given the increased proliferation of digital services – preventing the risk of “too large to convert” when proprietary technology and/or standards are entrenched.

[OGC open standards](#) are formally expressed in the form of Abstract Specifications and Implementation Standards, with the former providing higher-level information to technology leaders and managers, since understanding the strategic context of an open standard can be as important as its technical details. OGC Implementation Standards are written for a more technical audience and detail the interface structure between software components. When implemented by two different software engineers in ignorance of each other, the resulting components are expected to “plug and play” with each other.

Also supporting OGC’s goal of geospatial interoperability are the OGC API (Application Programming Interface) [family of standards](#) that are being developed to build upon the legacy of the OGC Web Service standards, through API “building blocks” taking advantage of modern web developments. Web services are standards for exchanging data between systems over a network, whereas APIs are software interfaces to allow two applications to interact with each other without any user involvement (including offline on the same system). All web services are APIs, but not all APIs are web services.

## The OGC Community of Interest

Complementing the OGC ecosystem of open standards are [OGC Best Practices](#) highlighting the practical use of OGC standards within a specific domain or to address particular use cases, while [OGC Community Practices](#) describe standards or specifications originating outside of OGC, but which make an important contribution to addressing interoperability requirements within geospatial communities. Ensuring that open standards remain relevant and aligned to emerging technologies, OGC also publishes [Engineering Reports](#), [Discussion Papers](#) and [Techpapers](#), alongside its [Compliance Testing](#) services for organisations.

The core of OGC activities are its many [Domain Working Groups](#) (DWGs) and [Standards Working Groups](#) (SWG), which encompass numerous domains and applications of geospatial data – including Land, Sea, Air, Space and Cyberspace, covering applications from Disaster Response to Defence Intelligence. DWGs provide a forum for important interoperability needs and issues, debate and review of implementation specifications, and presentations on key technology areas relevant to solving geospatial interoperability issues. SWGs have a specific charter for working on a candidate standard prior to approval as an OGC standard or on revising an existing OGC standard.

## How the OGC supports an IGIF-aligned MSDI implementation

The previous simplification of “Why” (UN IGIF), “What” (IHO MSDI), and “How” (OGC APIs) is an effective view of how OGC resources can contribute to the strategic vision of FAIR marine geospatial data, which is advocated by all three consensus bodies. This shared vision is important for demonstrating end-to-end evidence of strategy (UN), planning (IHO), and implementation (OGC), which is vital for organisational and inter-agency commitment. It can also contribute to national-level policy-setting by showing how an MSDI can contribute to an NSDI and a country’s overall goals for socioeconomic development. Outside of rare specific circumstances, an isolated and autonomous MSDI can be subject to unneeded risk if not connected or aligned with national governance, policy-setting, or strategy in the geospatial domain.

The OGC provides a practical toolbox of technological elements, supported by a wealth of community discussion and publications, for moving IGIF-MSDI considerations into real-world demonstrations. This is particularly crucial for short-term projects that provide the proof-of-concept, evidence, and realised benefits to support a longer-term programme of digital transformation. OGC resources provide the dual advantages of more immediate and practical results through smaller-scale interoperability (intra-agency and inter-agency), which by default of its consensus-based approval is automatically aligned with more strategic interoperability (national, international, vendor/supplier and futureproofing). The OGC offers the means and ways for organisations to govern the interoperability of new geospatial technologies, thus ensuring an IGIF-aligned MSDI can remain at the forefront of ICT capability (if/when this is a requirement).

[Insert OGC “landscape” diagram – ask TT to doublecheck for OGC ...]

Figure 4: OGC structure, groups, and resources – the technical “ecosystem” for supporting IGIF and MSDI

## Government Policies and National Strategy

Although this chapter is one of the shortest due to the infeasibility of describing the structures, impacts and dependencies of all potential national arrangements around the world; it however will have the most influence or constraints upon an IGIF-aligned MSDI and cannot be overlooked. On a general spectrum of Governance, political officials approve laws, legislation, and/or statutes, which are then implemented as detailed regulations and directives upon national agencies or government departments. These tools of hard governance may be supported by a national geospatial vision or strategy, national ethics framework for the use of public data, and industry codes of conduct or best practice guidelines at the market level. The expected progression is from hard governance (national law) that is unequivocal, down towards soft governance (sector best practice) that gives room for interpretation and adjustment. Every country will have its own ways of working and divisions of responsibility, which will influence and guide any IGIF-MSDI development programme.

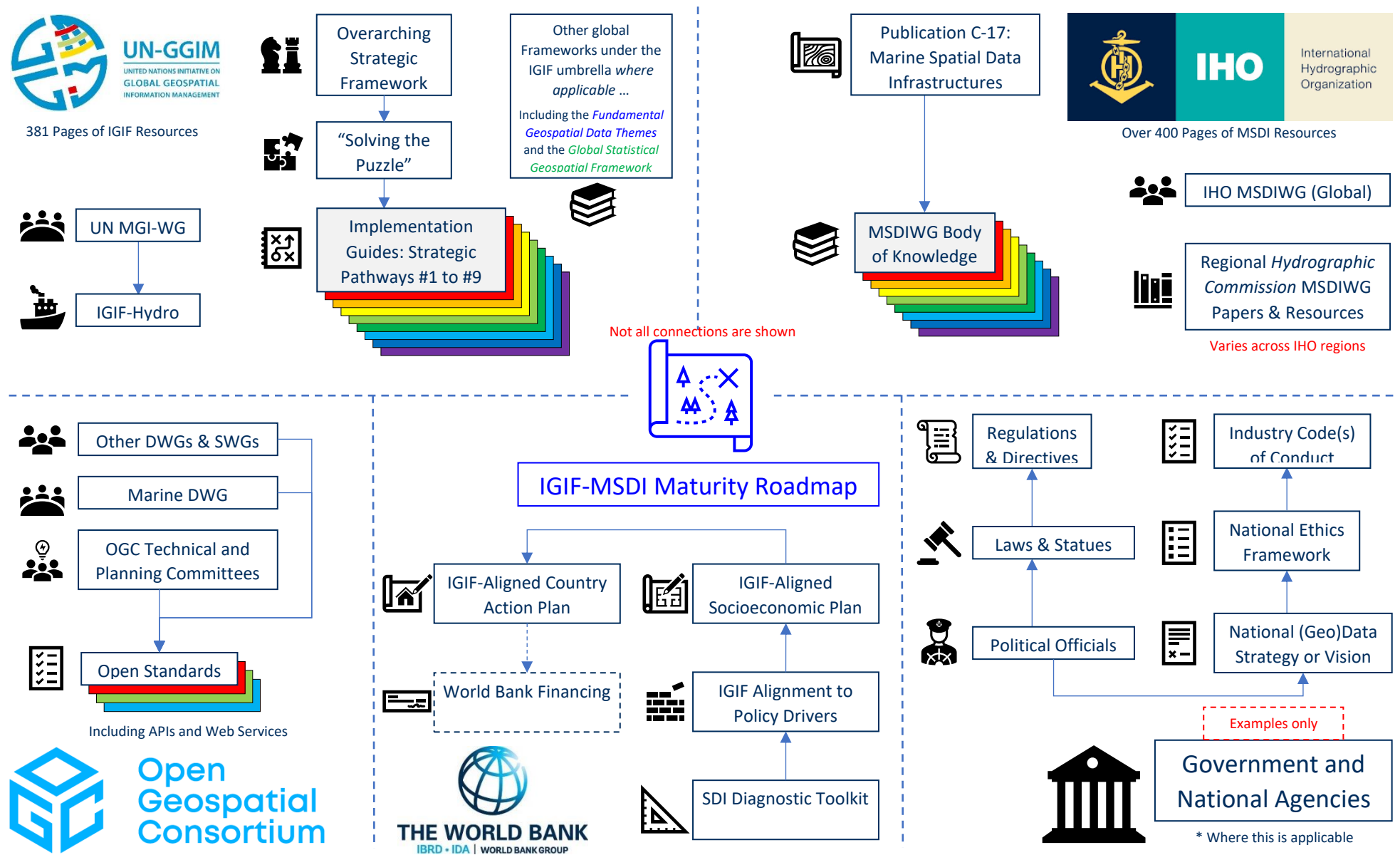
The most important consideration within this area is to identify national stakeholders and the landscape of governance, which would impact the development of an IGIF-aligned MSDI solution. Where possible, a visually engaging and clear infographic that highlights the connections between stakeholders, groups, agencies, departments, and tools of national governance, would help to ensure common understanding. The goal of such a resource when actively maintained, is to ensure that all IGIF-MSDI developments from agency strategy and policy-setting to technological implementation, are properly aligned from the start with national plans and priorities. This provides the positive outcome of potential national-level support for an IGIF-aligned MSDI, whilst mitigating the risks associated with divergence or perceived isolationism, which may lead to forced realignment of activities or a costly lack of technical and policy interoperability.

[Consult with SC on the Strategic Alignment to Policy Drivers process ...]

Later chapters of this IGIF-aligned Maturity Roadmap will highlight some “Soft Governance” Best Practice examples for building engagement and reaching consensus for driving practical progress, especially in situations where multiple marine and maritime agencies are essential for an effective MSDI. Within some national contexts (but not all), such agencies may have operated independently for a historically long period, developing unique Ways of Working and even legislative instruments that are specific to their responsibilities. Such contexts can create a tradition of “transactional” engagements with fellow agencies, reluctantly undertaken only when seen as unavoidable, alongside varying levels of agency and/or Data Protectionism. This is typically represented by comments such as “this is how our agency has traditionally managed X data for Y decades and it’s the way it’s always been done here”.

These later chapters are intended to provide a starting point for overcoming the frictions preventing the committed and collective decision-making needed for developing an IGIF-aligned MSDI, which itself is an essential component of a wider NSDI that covers air, land, sea, plus (optionally) space and cyberspace. Every national context is unique, so these starting points require adjustment to the political environment at hand and may not solve every inter-agency source of friction. It is nonetheless crucial to address such issues to ensure effective MSDI progress, which not one or even two agencies could deliver in isolation. In the absence of “Hard Governance” tools such as a National Geospatial legal mandate or the formation of a Department or Ministry of Geospatial Affairs (as an example), the use of Soft Governance techniques will come to the fore as an alternative approach in the interim.

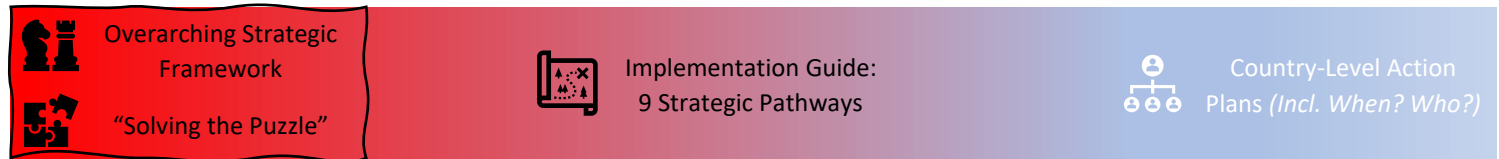
# (Simplified) Ecosystem of IGIF and MSDI Resources



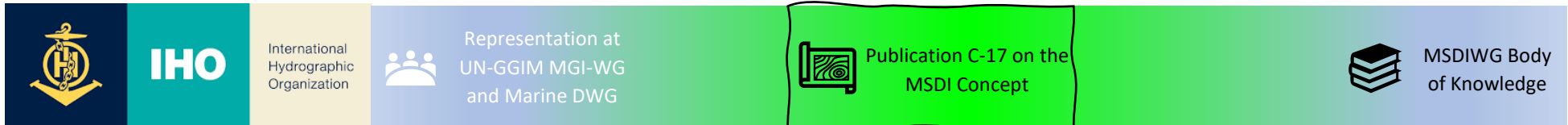
# Visual Context of UN-GGIM, IHO and the OGC



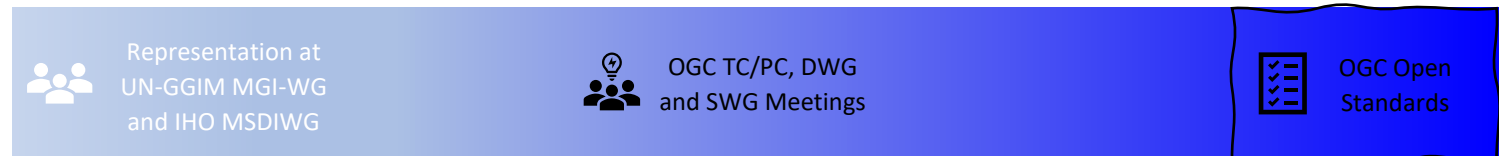
WHY? Socioeconomic motivations and inclusive benefits from global geospatial information management



WHAT? Developing a spatial data infrastructure suited for unlocking the value in marine and maritime data



HOW? Implementing OGC Standards to maximise the capabilities of Tech via cost benefits of interoperability



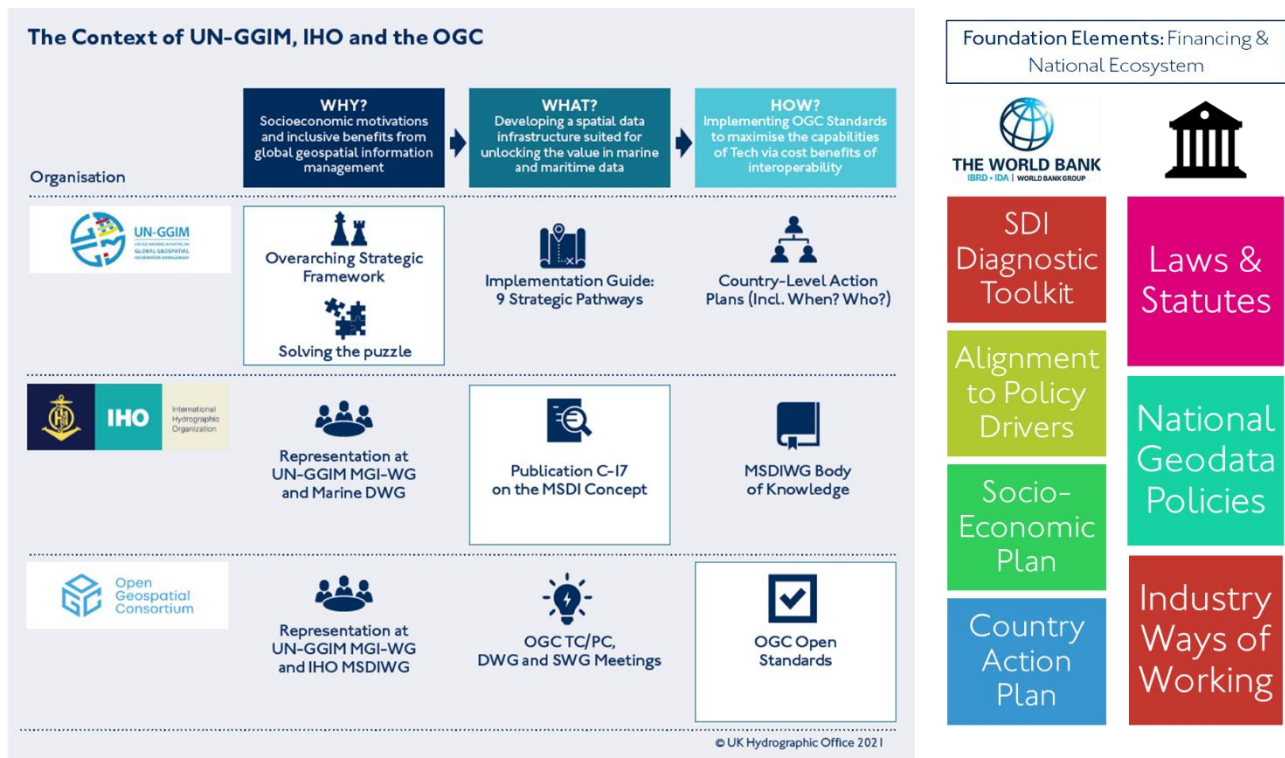


[Captions for previous two images – could not fit onto page without disrupting the images ...]

Figure 5: The (simplified) ecosystem of IGIF, MSDI and OGC resources – not all connections are shown. The IGIF-MSDI Maturity Roadmap seeks to provide a “quick start” guide to aid nations in beginning their IGIF-aligned MSDI transformation programmes.

Figure 6: The context for the UN-GGIM, IHO and OGC – considering the “Why”, “What” and “How” for charting a simplified narrative thread (or route) through the ecosystem of UN, IHO and OGC resources.

[New version of Figure 6 to replace the original– take the below as the actual image to use ...]



# Aligning an MSDI implementation with IGIF

## IGIF-MSDI Overall Concept: Harmonising Governance with Technology

As evident in the previous diagram, the ecosystem of IGIF and MSDI resources from both communities is extensive. Any harmonising between the two will necessarily be a simplification and there are likely many methods of aligning an MSDI to IGIF principles. The method adopted here is not intended to be complete, but only as a starting point or stepping-stone. Those benefiting from the approach taken here can choose to chart their own path forwards when they choose to, tailored to specific national needs, and hopefully sharing their unique experiences and challenges with the global community (via the UN, IHO and OGC).

The approach taken here is not to create a singular measure, metric, or pathway for an IGIF-aligned MSDI implementation, but a maturity roadmap that is “multi-dimensional” and gives opportunity for nations to interpret and manoeuvre. A single combined metric would be an oversimplification that would diminish the synergies that both an IGIF and MSDI approach can offer. “One size” does not fit all nations and such a reductionist approach would not do justice to either the IGIF or MSDI communities. It also incorrectly suggests that only one path forward exists for hydrographic offices to implement an IGIF-aligned MSDI.

### Side Note: Balancing Governance with Technology

This “multi-dimensional” approach also captures the general principle of balancing Governance for the socioeconomic benefit of all stakeholders, with the exploitation of new Technology being developed by private industry. This approach recognises that both areas have differing metrics of success, which need balancing where they overlap with occasional friction. One example is the ambition to maximise data access across a society competing with the need to respect the ownership rights of those that invested in creating data at time, effort, and cost. There are many others just as relevant, such as the emergence of autonomous shipping and the legal liabilities for accidents caused by inaccurate or incorrect use of spatial geodata by AI – leading to complexities around marine insurance, licensing, and compliance or assurance. The following diagram is a visual summary of balancing Governance with Technology for geospatial data.

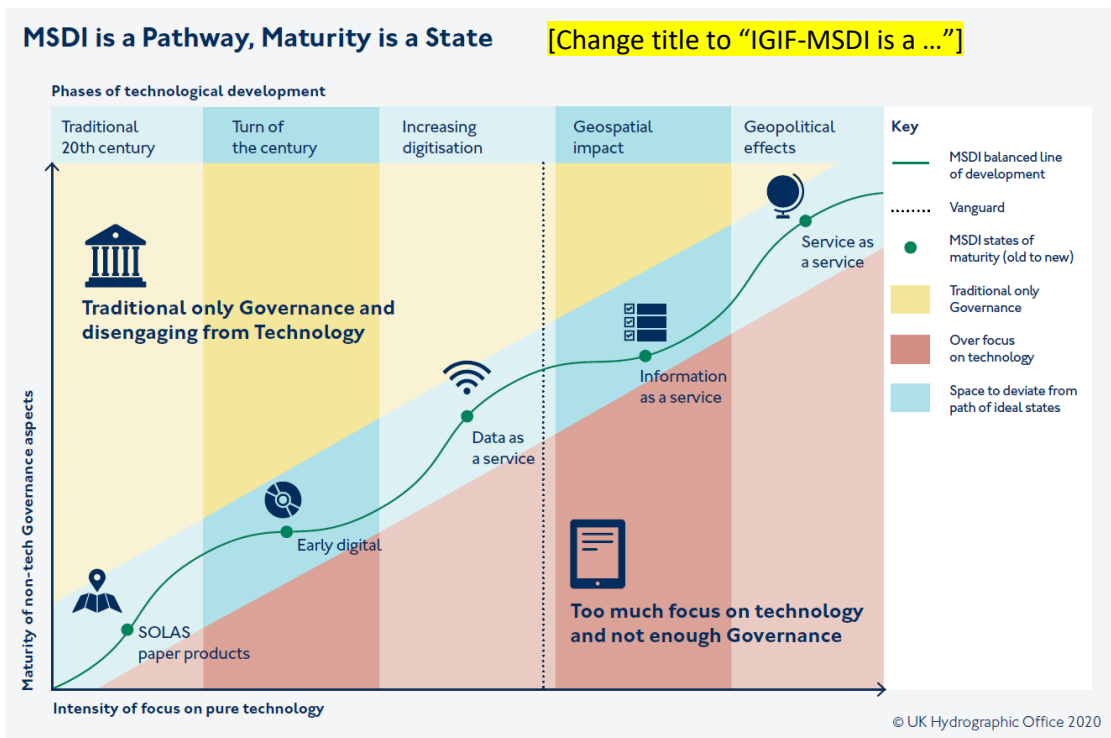


Figure 7: Balancing Governance with Technology – “2D” concept to aid general understanding.

- ✓ One axis is Governance – an approximation for the IGIF approach (for the purposes of this Side Note).
- ✓ Another is Technology – an approximation for the MSDI concept (for the purposes of this Side Note).
- ✓ It is entirely feasible to excel on one axis relative to the other and still have an effective IGIF-aligned MSDI, so long as this choice is deliberate, recognised and any potential shortcomings mitigated for.
- ✓ The optimal outcome is however ensuring adequate and sufficient Governance for the sophistication of Technology employed to ensure that net benefits are maximised for a given society and economy.
- ✓ Governance that is effective promotes inclusive and equitable outcomes across community groups, market sectors and national interests – thus supporting wider, sustainable economic development.
  - Governance should be sufficient to minimise negative impacts, such as on community privacy, business intellectual property, national security/safety, and uncompetitive market practices.
  - Governance should be adequate but not excessive, as new Technology requires some level of risk tolerance to fully realise its applications, benefits, and limitations over time.

---

*An effectively IGIF-aligned MSDI implementation should ideally  
“Drive Technology, rather than be Driven by Technology.”*

*The outcomes of an IGIF-aligned MSDI implementation should ideally  
“Make the Data count, rather than just Counting the Data.”*

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## IGIF-MSDI Requirement: Standardized Assessment to inform Business Cases

Given the wealth of policies, concepts, models, and qualitative thinking across both the IGIF and MSDI communities, there is a clear benefit to be gained from standardized assessment with a quantitative focus. Such an approach is not for regional comparisons, but to enable developing nations to determine their starting point on an IGIF-aligned MSDI implementation journey. Measuring or baselining a starting point is an essential first step in charting a practical course towards a nation’s desired end-state, which is ideally a balance between Governance and the Technology needed to achieve sovereign national requirements. An IGIF-aligned MSDI is not a “high-bar” threshold of cutting-edge Technologies, unless a nation decides that it is genuinely required for their geospatial development goals. It is the sovereign choice of a nation if they judge that current (or even last generation) Technologies are sufficient for their own aspirations.

Reaching that judgement and comparing it against a desired end-state, to chart a course between the two points requires a more quantitative and standardised approach. It also allows a “development trajectory” (generalised in Figure 7) to be plotted by reassessing at certain time intervals (annually or longer), so that political decision-makers can decide upon course corrections or adjusting final expectations. Without a known point of origin, it would be extremely challenging to plan a course/direction of development, let alone reach a desired end-state within reasonable time and cost.

One of the major drivers behind this IGIF-MSDI Maturity Roadmap is simplicity, which can be achieved by leveraging existing expertise from within the Terrestrial SDI community. The policy separation between Terrestrial and Marine is increasingly becoming a historical artefact or anomaly, especially as emerging technologies (via OGC Standards) are effectively “bridging the gap” between these two communities. The bulk of socioeconomic activity is naturally Terrestrial in nature and an MSDI should ideally synergise with an SDI to

form an encompassing NSDI (N for National – Air, Land, Sea, Space and Cyberspace). The World Bank offers such Terrestrial expertise via their SDI Diagnostic Toolkit, which also meets the requirement for a standardized assessment to inform a true business case (the quantitative “development trajectory”).

## The SDI Diagnostic Toolkit from the World Bank

Since its establishment in 1944 to support post-war reconstruction, the [World Bank](#) has supported over 12,000 development projects since its first loan in 1947 and is part of the [United Nations ecosystem](#). The World Bank goal of promoting shared prosperity is aligned with the 2015 [UN Sustainable Development Goals](#), supported since 2016 by an SDI diagnostic toolkit to inform economic-business cases. Conducted in 11 countries to date, these SDI-related World Bank resources are fully aligned with the UN-GGIM IGIF Nine Pathways, meeting a requirement for the standardized assessment of investment needs. In August 2017, the UN-GGIM affirmed a [collaborative agreement](#) between the United Nations’ *Statistics Division* and the World Bank’s *Global Practice on Social, Urban and Rural Development and Resilience*.

Via a scored set of questions answered during interviews conducted by the World Bank, the resultant indicators across the nine assessed categories suggest an optimal “[journey of SDI development](#)”. These indicators directly inform the standardised Assessment Report that sets an SDI baseline or starting point, from which World Bank funding can be assessed against via a subsequent geospatial business case. One notable example from this geospatial approach was the recent 5-year investment of the World Bank in Albania of over one billion USD into land infrastructure and NSDI development. Directly informed by the World Bank’s SDI diagnostic toolkit, these [geospatial business cases](#) (when undertaken) can critically form the quantitative and socio-economic backbone of Country-level Action Plans within the IGIF approach.

One caveat and opportunity, hopefully realised by *this* IGIF-MSDI Maturity Roadmap, is that the current SDI diagnostic toolkit can be augmented with IHO MSDI domain knowledge, via its in-built flexibility to accommodate questions that are of particular importance to a given nation. As is the approach taken here (in later chapters), the inclusion of MSDI-specific aspects can make the already robustly IGIF-aligned SDI diagnostic toolkit even more useful to developing island nation states. Adapting the World Bank’s SDI toolkit via the IHO’s MSDI contribution is the *quantitative* counterpart of the IGIF-H Operational Guide, which itself seeks to *qualitatively* adapt IGIF for the hydrographic community. (Although IGIF proper could be applied “as-is” to the marine domain, its land-based origins provide ample opportunity for tailoring.

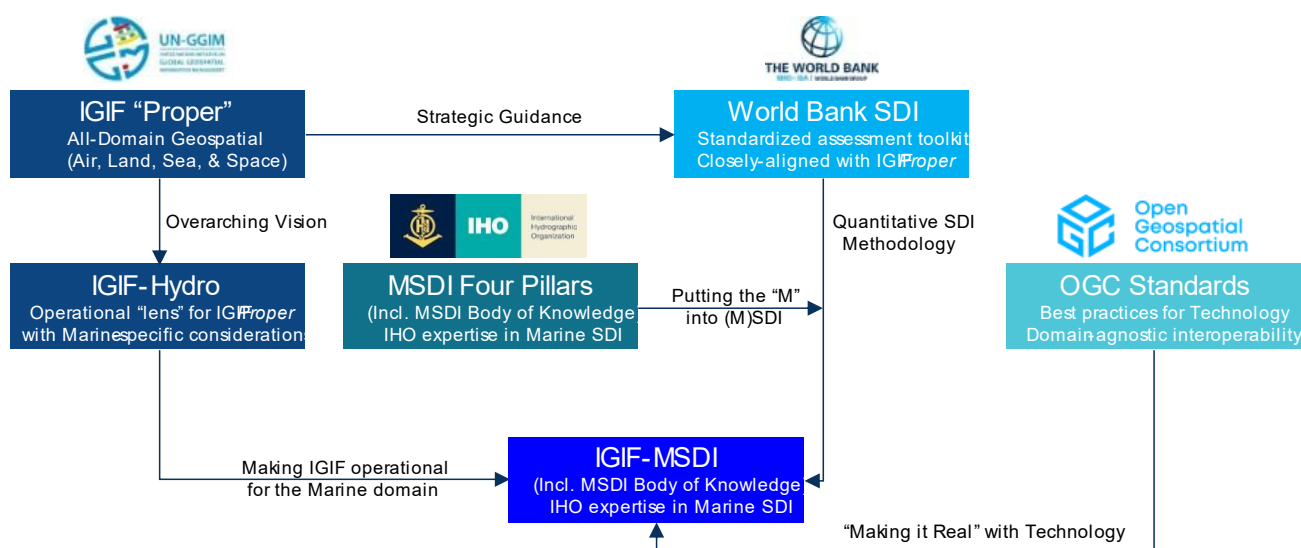


Figure 8: The relationship between the major influences and key contributions to the IGIF-MSDI Maturity Roadmap – for general awareness only and not a precise or formal mapping.

*A useful analogy here is that the IGIF-H Operational Guide from the UN WG-MGI adds the “H” for Hydro to IGIF proper, whilst the IHO MSDI Body of Knowledge appends the “M” for Marine to the World Bank’s existing SDI methodology.*

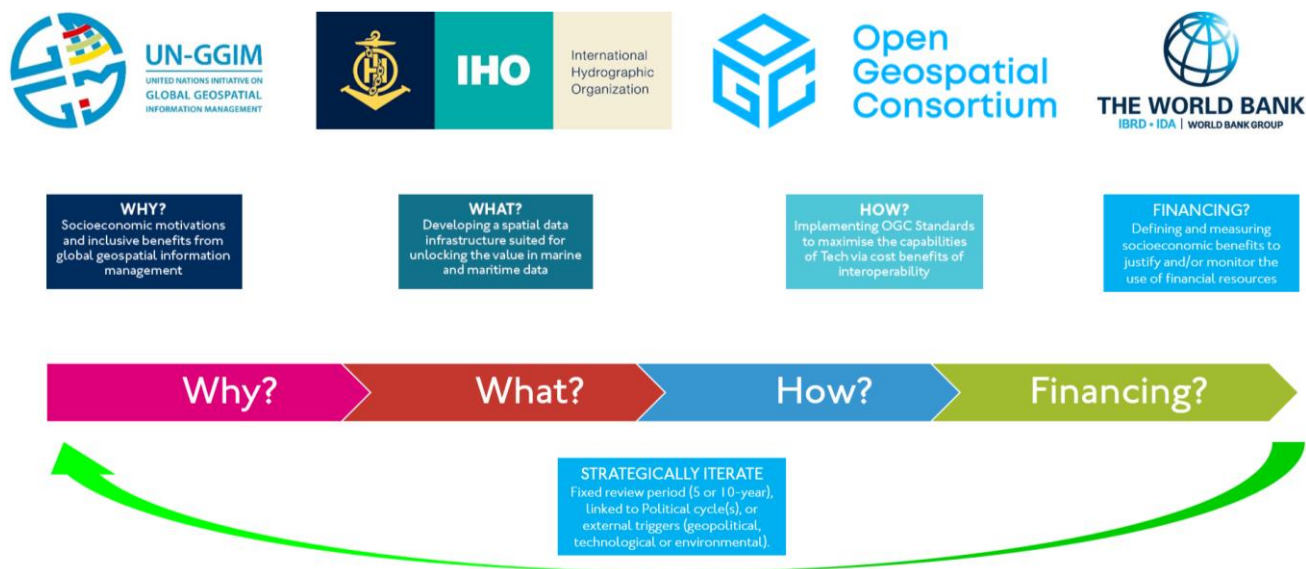


Figure 9: The IGIF-MSDI contributes to drawing together four key areas of consideration around an IGIF-aligned MSDI implementation – the “Why”, “What”, “How”, and “Financing” aspects (with future iteration).

### Augmenting the SDI Diagnostic Toolkit with IHO MSDI and OGC Contributions

The comprehensive version of the World Bank SDI Diagnostic Toolkit consists of 91 detailed questions, which are best applied via the expertise of the World Bank or its approved associates, to ensure a robust and credible outcome to support funding decisions. Significant thought and consultation were applied to the composition, wording and ordering of these 91 detailed questions across 9 categories, leading to a multi-dimensional “radar chart” that leads into the next stages of the World Bank SDI methodology. For the purposes of this IGIF-MSDI Maturity Roadmap, (M)SDI baselining is the primary focus here, although future versions in due course are likely to further reference, connect, or synergise with the World Bank.

# World Bank IGIF Methodology (with IHO MSDI Contribution)

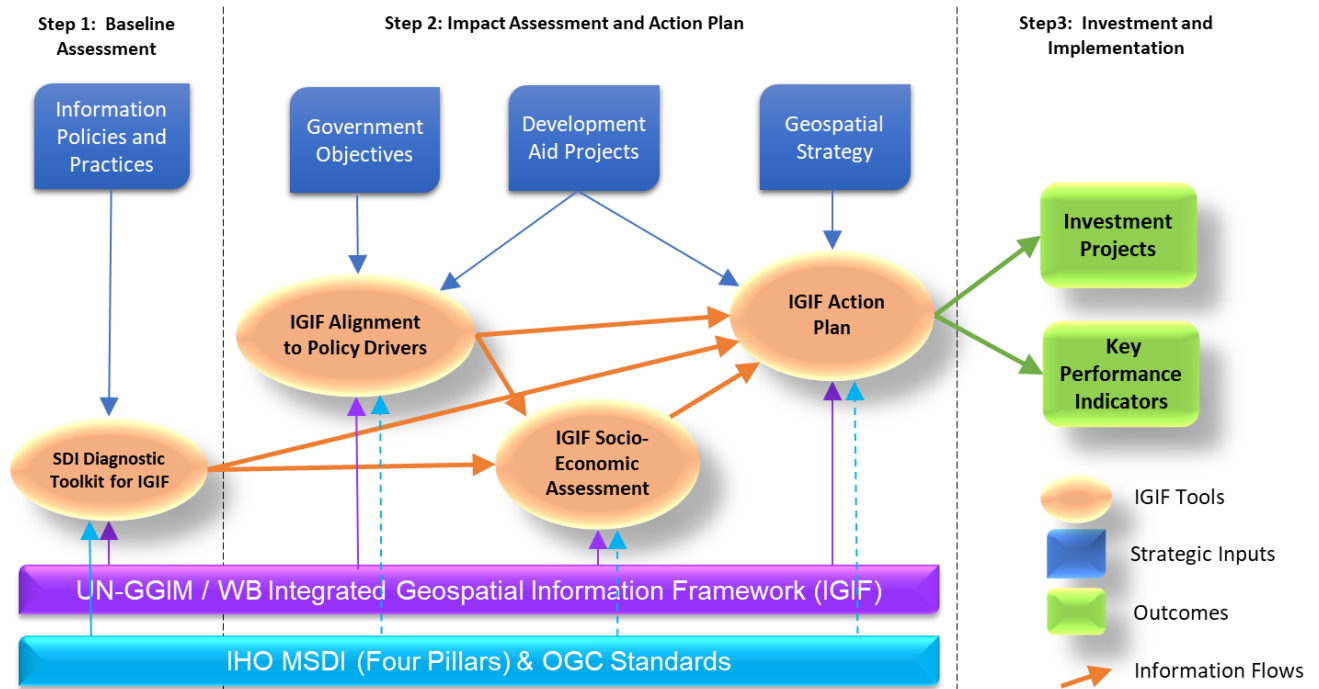


Figure 10: The World Bank IGIF Methodology relies on the SDI Diagnostic Toolkit for baselining, which unlocks the later steps towards Investment and Implementation. The addition of IHO and OGC inputs, adds the “M” into (M)SDI with assured interoperability whilst maintaining *whole-of-nation* NSDI alignment.

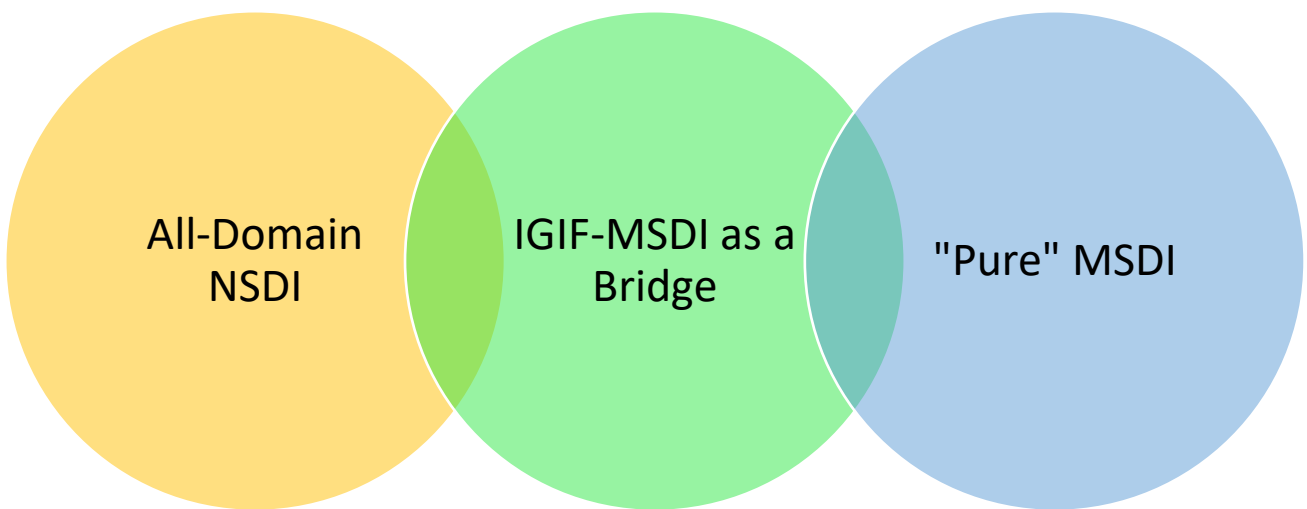


Figure 11: The IGIF-MSDI Maturity Roadmap enables the explicit connection of an MSDI to an All-Domain (or *whole-of-nation*) NSDI, whilst preserving the unique marine considerations needed within an MSDI.

The SDI Diagnostic Toolkit is structured such that it can be applied on the National level or simplified for key stakeholder groups and/or individual geospatial agencies. The approach taken here is to combine the pre-existing “Decision Maker” and “End-User” versions of the SDI Diagnostic Toolkit, whose subset(s) of the full 91 question version have some simplifying overlap, followed by questions drawn from the IHO MSDIWG *Body of Knowledge* (incl. Publication C-17) and relevant resources from the OGC community. Combining these two subsets is justifiable, as Hydrographic Offices (or their national equivalents) are generally the facilitators between the “Decision Maker” (political/legal geospatial Governance) and “End-User” (enforcing or subject to Governance) communities. One example here is the legal creation of a Marine Protected Area by political

officials (“Decision Maker”) for environmental or economic reasons. This is then facilitated by a Hydrographic Office via authoritative geospatial data and information, which is then applied by Marine Enforcement bodies and/or used by shipping companies directly (“End-User”).

Aside from simplifying the full 91 question version (best suited for a *whole-of-nation* baselining effort) to aid effective application within the Marine domain, augmenting with IHO and OGC derived questions also provides additional benefits. By augmenting instead of replacing, this firstly ensures that responses to the “pure” SDI element can directly contribute to a *whole-of-nation* baselining effort, as the Marine community input into an NSDI vision, thus highlighting the relevance of Marine affairs as essential to a true NSDI and not simply an adjunct to Terrestrial affairs (the outmoded “Wet Land” perspective). The second benefit is related to the first, where the IHO and OGC specific elements can be recycled into plans, policies, and initiatives in those respective areas – such as Marine Spatial Planning or a Standards Implementation Strategy.

These two benefits provide the “upstream” and “downstream” connections for the IGIF-MSDI Maturity Roadmap, to national-level geospatial strategy (NSDI) and real-world technological implementation (in the Marine domain) respectively. By being able to recycle “pure” SDI elements (whether air, sea, or land) and Marine-domain specific elements, it helps to mitigate against duplicated effort in the medium-term. (It is reported that aligning with multiple models or approaches can create an overhead for Hydrographic Offices, in terms of their Subject Matter Experts and their availability for *business-as-usual* priorities.)

## Existing links between UN IGIF, World Bank SDI, IHO MSDI and OGC Resources

Although many initiatives and projects exist in a bilateral and multilateral manner between the UN, IHO, OGC, and World Bank, there are some existing links that are relevant for the purposes of this IGIF-MSDI Maturity Roadmap. To optimise the application of this Maturity Roadmap, it is highly recommended that these existing joint resources be referred to and understood within the context of an MSDI as a strategic input to a wider NSDI (Air, Land, Sea, plus Space and Cyberspace *if applicable*).

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[“A Guide to the Role of Standards in Geospatial Information Management”](#) (August 2018) – This joint publication between the OGC, ISO TC-211<sup>1</sup>, IHO, and the UN addresses the role of open standards in geospatial information management. It defines what an open standard is, why they are valuable in use, and describes best practice around geospatial standards. It also introduces a goal-based approach to standards adoption and a multi-tiered “Geospatial Levels of Standards Use”.

[“Companion Document on Standards Recommendations by Tier”](#) (August 2018) – This document describes which OGC standards may be optimal to use for each Tier as identified within “A Guide to the Role of Standards in Geospatial Information Management”. Also outlined are the foundational standards generally required to implement any internet-based solution. No information technology standard exists in isolation and hence most OGC standards reference one or more of these foundational standards.

Both publications are crucial for the practical and operational implementation of an IGIF-aligned MSDI, by moving beyond strategy or policy considerations and towards “making it real”. The first document provides the governance model and best practice around implementing standards for an organisation using a tiered approach. The second document provides the open and foundational standards that can be practically used by Data Architects (or similar role) for a prototype or operational IGIF-aligned MSDI.

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<sup>1</sup> International Organization for Standards (ISO) *Technical Committee 211* for Geographic information & Geomatics

[Add more links, presentations, publications, or initiatives that are directly relevant for this document]

## The IGIF-(M)SDI Diagnostic Toolkit

### Structure and Format: Modular and Interoperable

[Explain the fusion between the End-User and Decision-Maker subsets, plus IHO and OGC contributions]

### Diagnostic Toolkit Outputs: Multi-Dimensional Baseline

[Explain the 9D radar output that gives national agencies room to manoeuvre – better than a 1D metric]

### Onwards Steps: Charting a Course towards Practical MSDI Implementation

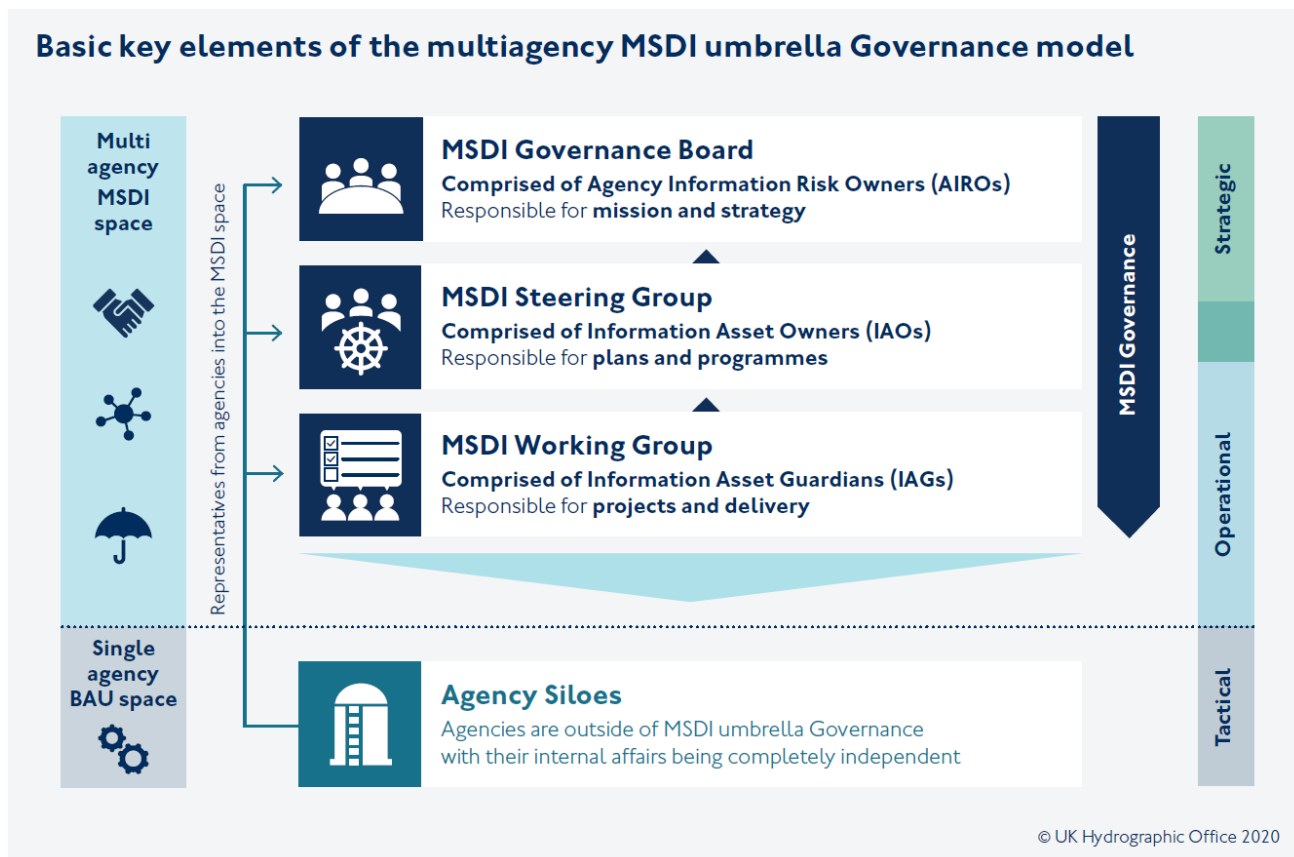
[Creating an MSDI Action Plan to raise maturity in *selected* weaker areas and to leverage strengths]



# Multiagency MSDI Governance – Best Practice

Umbrella Governance Model for Established Agency “Ways of Working”

Umbrella Governance: Extensible for Intra-Agency and Regional MSDI Practice



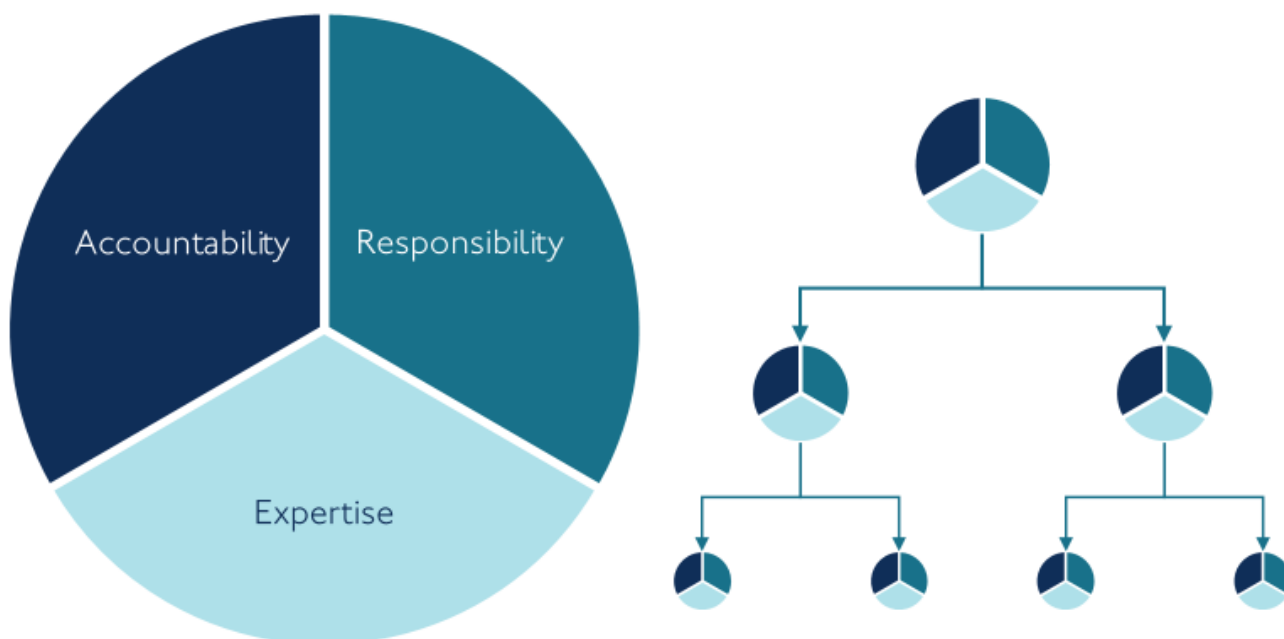
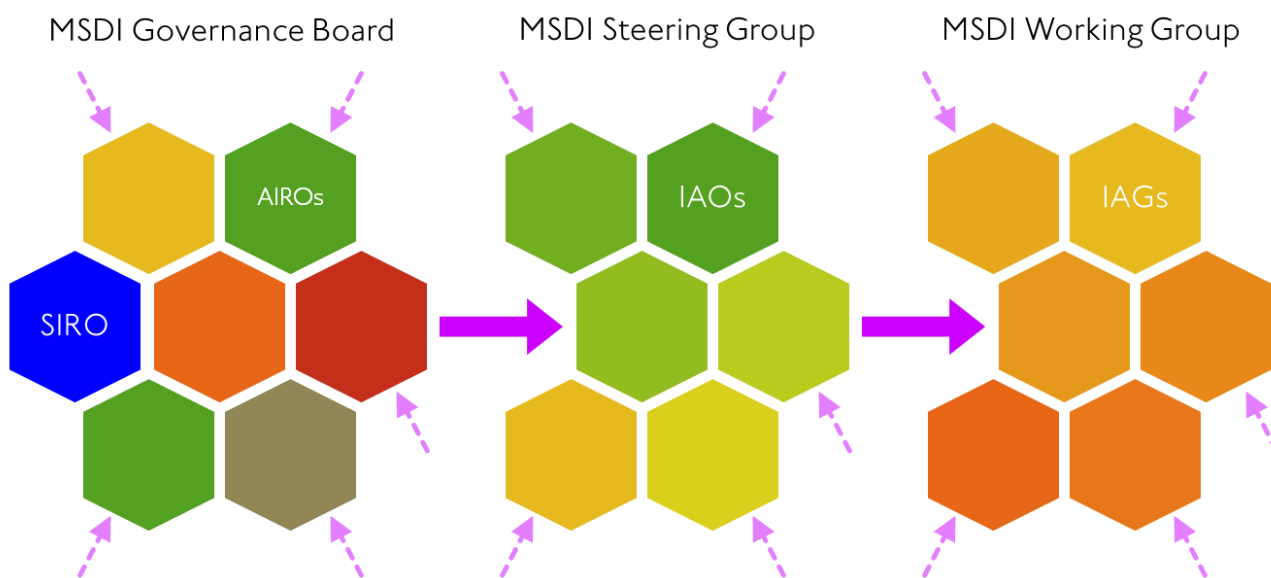
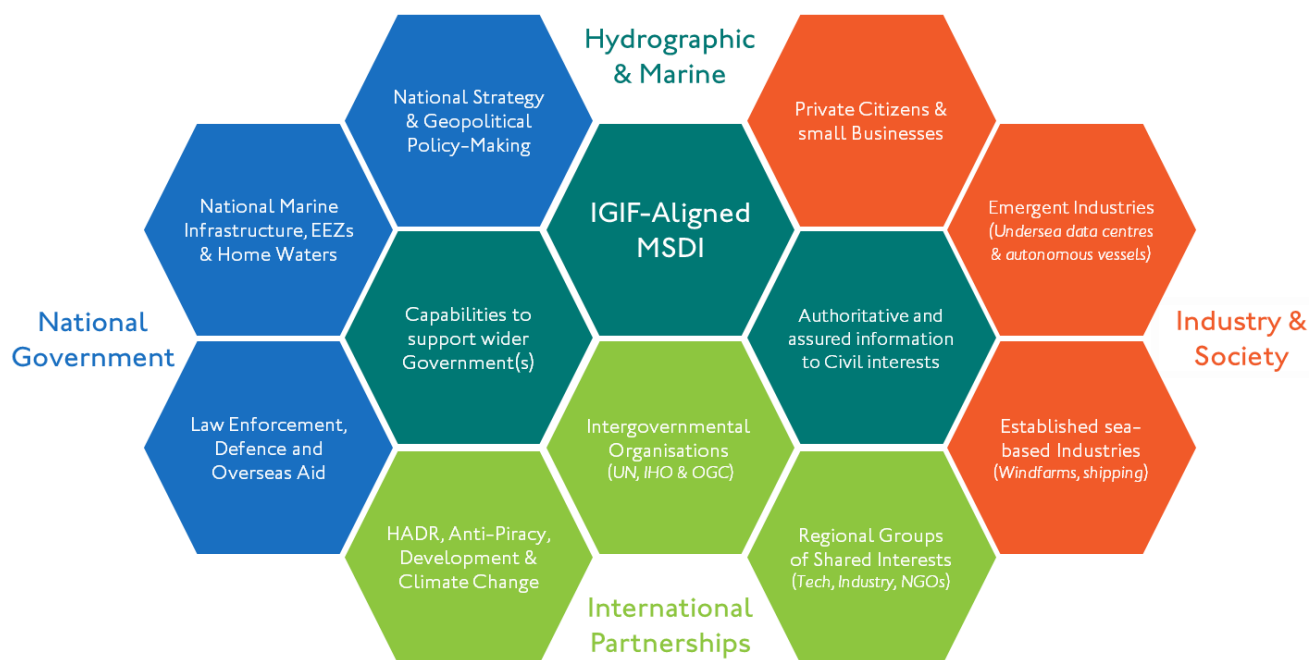


Figure 12: Due to the fast pace of Technological change and dependencies between Stakeholders, even only within one MSDI Agency, the development required to sustain an effective MSDI implementation is best supported by decentralisation and a balance of Accountability, Responsibility and Expertise.



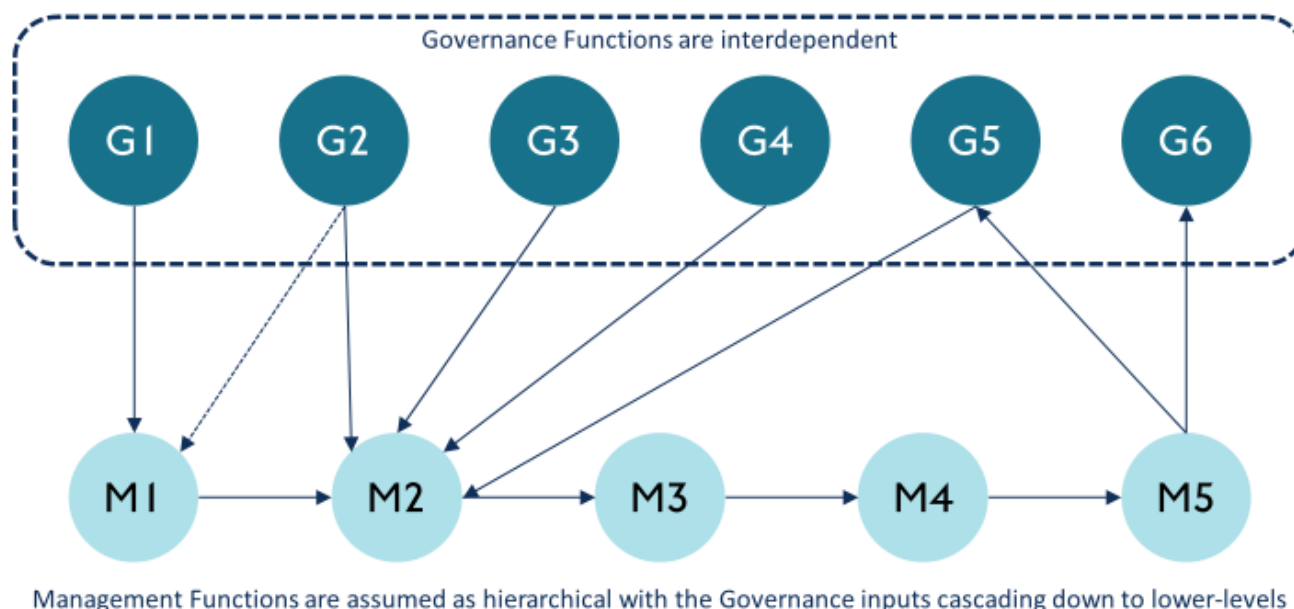
Collaborative, cooperative and consensus **decision-making** via representatives or *ambassadors* from each MSDI Agency.

## Virtual MSDI Enterprise

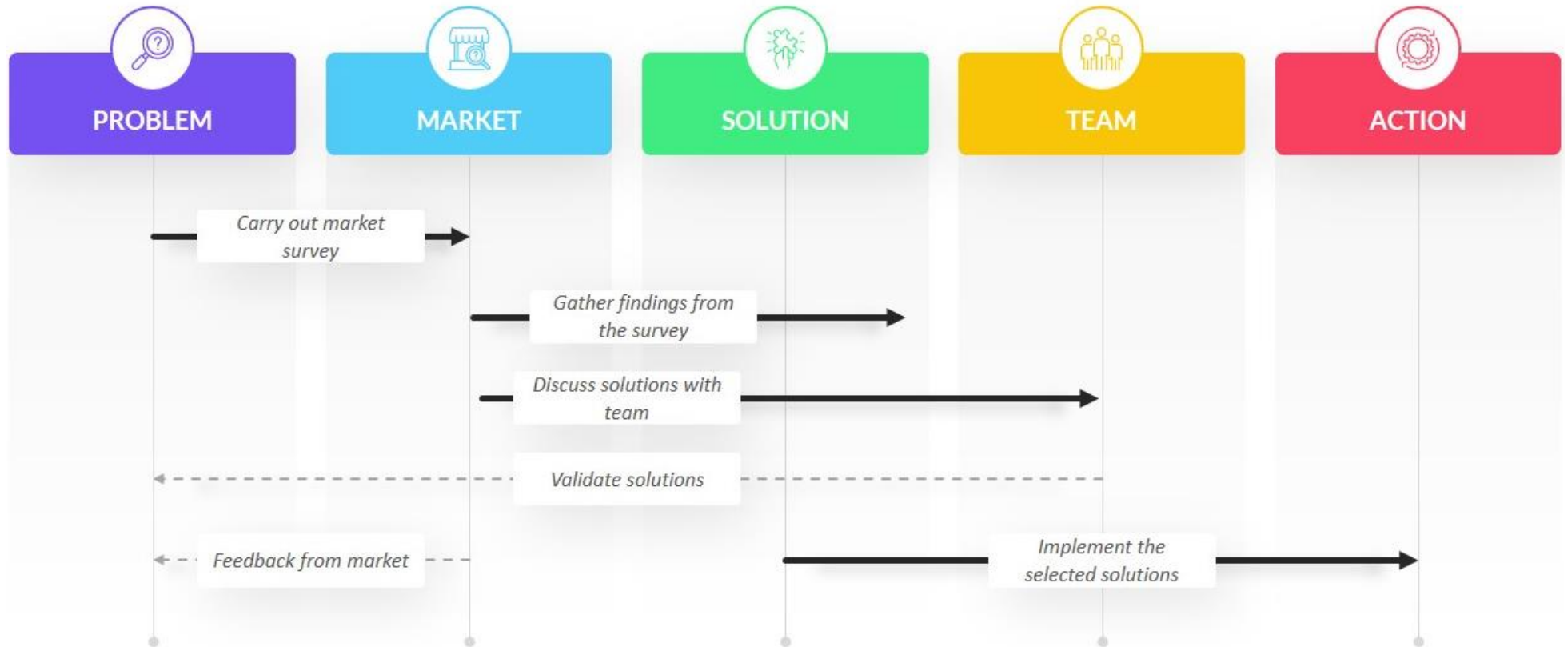


## MSDI Governance ≠ MSDI Management

Governance Functions		Management Functions	
G1	To determine the <b>objectives</b> of the organisation	M1	To <b>forecast</b> and <b>plan</b>
G2	To determine the <b>ethics</b> of the organisation	M2	To <b>organise</b>
G3	To create the <b>culture</b> of the organisation	M3	To <b>command</b> or <b>direct</b> (lead)
G4	To <b>design</b> and <b>implement</b> the governance framework	M4	To <b>coordinate</b>
G5	To ensure <b>accountability</b> by management	M5	To <b>control</b>
G6	To ensure <b>compliance</b> by the organisation		



# SEQUENCE DIAGRAM



This generic/template Sequence Diagram needs redesigning for more impact and consistency with the other graphics

## More Random Placeholder Text

### Translation of Cicero's "*de Finibus Bonorum et Malorum*"

"But I must explain to you how all this mistaken idea of denouncing pleasure and praising pain was born and I will give you a complete account of the system, and expound the actual teachings of the great explorer of the truth, the master-builder of human happiness. No one rejects, dislikes, or avoids pleasure itself, because it is pleasure, but because those who do not know how to pursue pleasure rationally encounter consequences that are extremely painful. Nor again is there anyone who loves or pursues or desires to obtain pain of itself, because it is pain, but because occasionally circumstances occur in which toil and pain can procure him some great pleasure. To take a trivial example, which of us ever undertakes laborious physical exercise, except to obtain some advantage from it? But who has any right to find fault with a man who chooses to enjoy a pleasure that has no annoying consequences, or one who avoids a pain that produces no resultant pleasure?"

### Instead of "Lorem Ipsum" that Microsoft *Word* red-flags as misspelt

"On the other hand, we denounce with righteous indignation and dislike men who are so beguiled and demoralized by the charms of pleasure of the moment, so blinded by desire, that they cannot foresee the pain and trouble that are bound to ensue; and equal blame belongs to those who fail in their duty through weakness of will, which is the same as saying through shrinking from toil and pain. These cases are perfectly simple and easy to distinguish. In a free hour, when our power of choice is untrammelled and when nothing prevents our being able to do what we like best, every pleasure is to be welcomed and every pain avoided. But in certain circumstances and owing to the claims of duty or the obligations of business it will frequently occur that pleasures have to be repudiated and annoyances accepted. The wise man therefore always holds in these matters to this principle of selection: he rejects pleasures to secure other greater pleasures, or else he endures pains to avoid worse pains."

### Spreadsheets and Tables will require Visual Impact

Main Title	Column A	Column B	Column C	Column D	Column E
Row 1	Institution X	Entry X	Data X	Letter X	Value X
Row 2	Institution Y	Entry Y	Data Y	Letter Y	Value Y
Row 3	Institution Z	Entry Z	Data Z	Letter Z	Value Z
Row 4					
Row 4					

Need a visually impactful back  
page to match the front



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