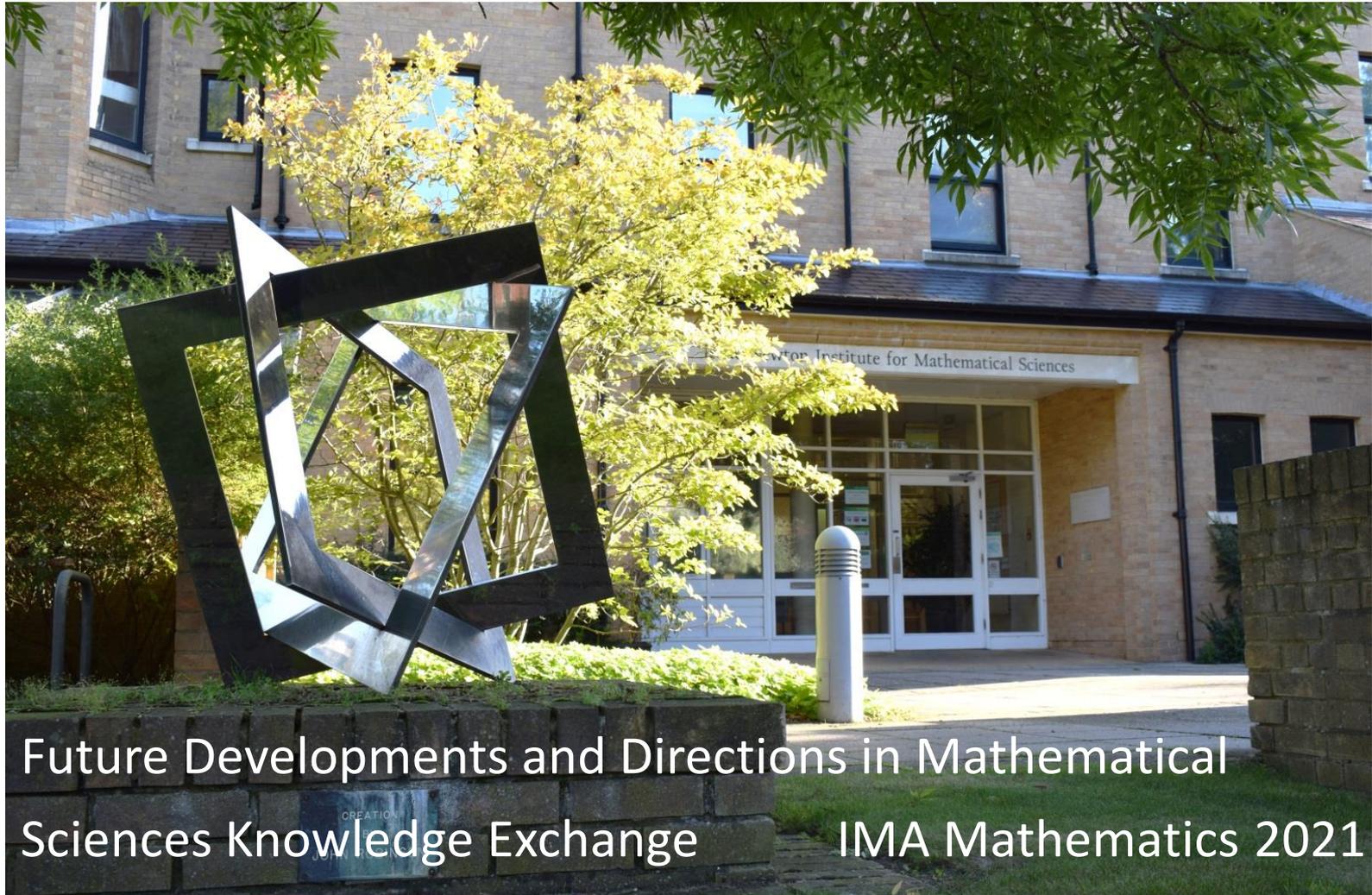


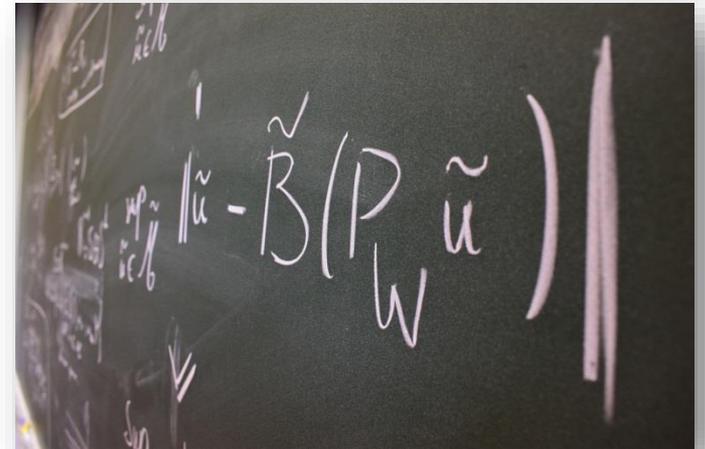


# Isaac Newton Institute for Mathematical Sciences



# Newton Gateway to Mathematics

- Impact initiative of the Isaac Newton Institute for Mathematical Sciences (INI)
- Launched March 2013 with four Open for Business workshops:
  - Industrial Statistics
  - Policy Support in Communities and Local Government
  - Stochastic and Statistical Models at the Interface of Modern Industry and the Mathematical Sciences
  - Mathematics of Liquid Crystals: Industrially Inspire Problems
- Inspired by the 2012 six month research programme on “Semantics and Syntax: A Legacy of Alan Turing”. 100<sup>th</sup> anniversary of Turing’s birth
- Linked to the INI grant proposal and a recognition of the importance of formal mechanisms for delivering impact
- Originally created to develop impact from INI programmes via “Open for Business” events



## **Knowledge Intermediary for mathematical sciences in the UK**

- Helping get mathematics to potential users – other disciplines, researchers in business/industry, public sector
- We do this via Broad brokering, specific brokering
- User engagement – communication, facilitating, translating to maximise KE
- Delivered over 100 events to date, with more than 7000 participants and partnered with over 700 organisations

## **KE support /impact for Isaac Newton Institute Research Programmes**

- Activities and workshops to bring end-users together with INI programme researchers, funding assistance
- As part of the INI - access to world-leading academics on Institute programmes

## **Developing and delivering activities for mathematical sciences KE**

- Partnering with industry, funders, Government, Institutions, Learned Societies, networks
- Working with the UK mathematics community – the Bond Review of Knowledge Exchange in the Mathematical Sciences, joint initiatives, best practice

**Enhanced Open for Business** events, drawing out impact (from social, through policy to engineering) from INI programmes – examples include:

- Engaging People in Data Privacy, December 2016 – linked to the Data Linkage & Anonymisation Programme in partnership with EPSRC and GCHQ
- 100% Renewables – Future Challenges in Energy Systems; linked to INI Programme and with support from National GridSO
- Mathematics of Sea Ice Phenomena - British Antarctic Survey Satellite Workshop, September 2017 as part of Sea Ice Phenomena INI Programme
- INI - Schlumberger Satellite Workshop - Application of Optimal Transport, October 2017 as part of Imaging and Vision Programme
- Verified Software, September 2019 (with VeTSS, the UK Research Institute in Verified Trustworthy Software Systems)
- Understanding Multi-Modal Data for Social & Human Behaviour – linked to Scaling Limits, Rough Paths Quantum Field Theory, November 2018 and supported by BAE Applied Intelligence. Continuing with DataSig Programme

## **Reflecting the diverse and underpinning nature of mathematics**

- Recognising the opportunities, and need, for impact from MS research, the Gateway increased its calendar of meetings each year that are not connected to the INI programmes; events typically one or two days long
- Achieved to a large extent by working in partnership with various individuals and groups, and as a delivery partner
- Helping develop communities and build capacity for important science and technology areas

## **Types of Activities**

- Programmes of work, identifying experts in academia and industry, community building, research scoping/horizon scanning events, knowledge exchange/dissemination type workshops, consultations and study groups

## **Evolving with the Pandemic**

- A need to be collaborative, reactive and agile – more on this later

## Research Scoping/Horizon Scanning Workshops

- **Novel Computational Paradigms, 30<sup>th</sup>-31<sup>st</sup> Oct 2018** - partnership project with GCHQ and others. Horizon scanning bringing together experts from multiple disciplines to investigate novel technologies beyond quantum computing. (Computer science, AI, materials, biological informatics, computational neuroscience, synthetic biology).
- **Evidence Based Decisions for UK Landscapes, 17<sup>th</sup>-18<sup>th</sup> September 2018** – part of a programme of work with NERC and Defra incorporating research, community building, an end-user stakeholder survey, linked funding calls and an INI one month research programme in July 2019. Linked to UKRI future strategies in this area.

## Study Groups

- National Centre for the Replacement Refinement & reduction of Animals in Research (NC3Rs), Maths Foresees Network – environmental modelling, European Study Groups with Industry (ESGI).

## Knowledge Exchange/Dissemination Events

- **100% Renewables – Future Challenges in Energy Systems, 23<sup>rd</sup> Jan 2019** – part of the INI Programme on The Mathematics of Energy Systems. 42% of attendees were non-academics. Highlighted the significant research challenges associated with the move towards more renewables in our energy systems. Funded by National Grid ESO, including talks from energy supply chain stakeholders – DNOs, generators, etc.



## Other Activities

### Distributed Ledger Technology, 6<sup>th</sup> November 2019 –

A partnership project with GCHQ, Digital Catapult and EPSRC

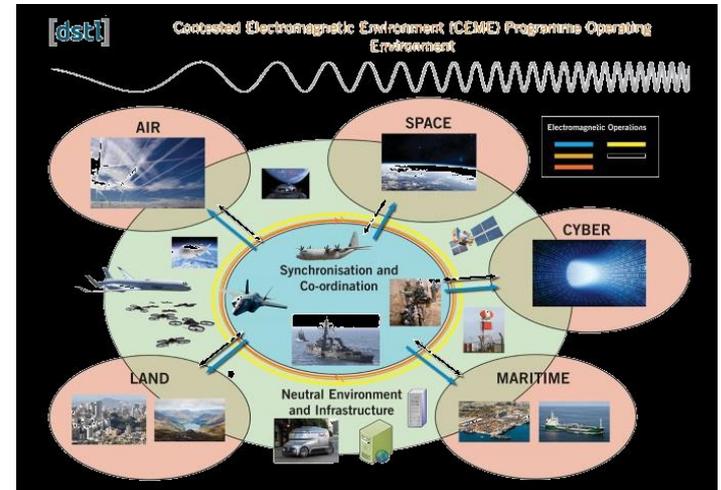
- Investigating the potential and possibilities of DLT as a technology for both Government and the UK as a whole.
- Extensive research and consultation across stakeholders
- A need to understand the landscape in order to create a day of talks and discussion that is relevant and interesting
- ISSUES - the need for clarity - to separate the hype from the reality and where there are no current plans to fund the technology and no working strategy
- Therefore a focus of this one day workshop was to highlight appropriate use cases and promote research into scalable DLT
- Overview and context – academic talk to outline what the technology can do, Dutch Blockchain Coalition presenting a national approach and the Catapult talking about the business of Blockchain
- Legal aspects – UK Jurisdiction Taskforce Legal Statement on Cryptoassets and Smart Contracts
- An investor perspective from Outlier Ventures and a panel discussion exploring future prospects



## Mathematical Challenges in the Electromagnetic Environment

A collaboration with DSTL and PA Consulting (2019-2022)

- To create a mathematical framework for the Synchronisation of the Congested Electromagnetic Environment (CEME)
- Bringing together experts from a number of diverse fields comms, electronics engineering, signal processing, OR and optimisation, scheduling, queuing, graph and information theory, radio astronomy
- A mathematical approach may provide novel insights that conventional approaches could not, creating a catalyst for prototype research and ideas for new technology solutions
- Two 3 day challenge workshops in January 2020, virtual in September 2020, 3 day virtual study group January 2021. Working on a number of formulated challenges
- Outputs will be a number of funded short-term projects
- Part of a three year DSTL funded programme seeking to build a multi-disciplinary network of experts
- Working with end-user and domain experts consultants to help bring access to the mathematical sciences
- Setting up a SIG group on Knowledge Hub (digital community platform) ahead of a further event in July 2021



## 4-Dimensionalism in Large Scale Data Sharing and Integration

A collaboration with GCHQ, UCL, Brunel, Southampton and Warwick (22<sup>nd</sup> April 2021)

- To highlight the potential of 4D and build a community which will include bringing together branches of the maths community
- 4-dimensionalism has a critical role in providing both mathematical & logical rigour to data sharing and integration
- The National Digital Twin Programme looks to scale up over the next decade but it needs people with 4D skills to do this
- A day event held virtually which presented the 7 circles of information management
- Outputs will be a number of funded short-term projects
- A survey is being conducted to measure interest and insights from the diverse mix of participants who attended the event
- Working with the 4D SIG and the Centre for Digital Built Britain to develop this area
- Gateway will play a role in outreach to a wider audience interested in understanding about the more technical aspects and helping to open up the discussion. Educational aspect to help develop a more knowledgeable community.



- Growth in Gateway's remit, with increased number and variety of events, and reflecting its larger societal responsibilities
  - the Gateway Governance (and name) was revamped in 2019 ... now has two strong committees that advise and tension the staff:
    - Scientific Advisory Panel
    - Gateway Advisory Board (members from business, industry, government etc)
  - The Gateway staff numbers were increased, and more INI/Gateway interactions, to manage the increased complexity
  - Gateway has increased collaborations with sister organisations: ICMS, KTN, ATI, IMA etc.
  - Establishment of V-KEMS

Some of the new ways of interaction, which will now be standard practice:

a. Aforementioned study groups – especially virtual study groups employed during lockdown as part of V-KEMS

b. Strategic INI programmes, eg:

Challenges in Landscape Decision-making, July/August 2019 - funded and partnered with NERC (from a conversation with Duncan Wingham)

c. Substantial partnering activity to create a new community, eg:

DSTL funded, partnership with PA Consulting on Congested and Contested Electromagnetic Environment

d. Brokering, eg:

Innovate UK's A4I activity – Analysis for Innovators, connecting mathematicians with companies who need help to solve tricky and, perhaps, long running technical problems affecting existing processes, products or services.

e. Modelling camp:

Hosting annual Grad Camp on mathematical modelling (formerly OCIAM)

## The pandemic

- Rather than curtailing the work of the Gateway, Coronavirus has led to a very significant increase in its role, and that of INI
- Gateway's range of shorter activities work well in virtual setting – development of a 'tool kit' of technologies and software for online delivery
- In March 2020, partnered with ICMS and KTN to form V-KEMS, whose activities will be discussed in detail in Week Two of Mathematics 2021
- Recently joined with the Royal Society's Rapid Assistance for Modelling the Pandemic (RAMP) Initiative to pull-through the impact of its various tasks, and
- Work with Juniper consortium
- New V-KEMS development – GCHQ summer internships working on V-KEMS projects and potential Heilbronn Institute collaboration for a distributed summer school in 2022
- EPSRC additional Funding to INI which will allow the INI and Gateway to expand activities to better connect with the whole mathematical sciences community

# The Current State of Play

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## Summary

- Jane has presented an overview of the expanding role of the Gateway – showing its engagement mechanisms and a sample of the work that has taken place
- The Gateway was a fairly independent arm of INI, but the name change signifies the much deeper engagement with INI – recognising that impact is central to its remit
- Much more permeable walls between what is INI and what is Gateway activity
- ICMS has recently significantly increased its KE activity too
- V-KEMS has scaled up the interactions between INI/Gateway and ICMS and we are now seen as THE research infrastructure for UK Mathematical Sciences

# The Current State of Play

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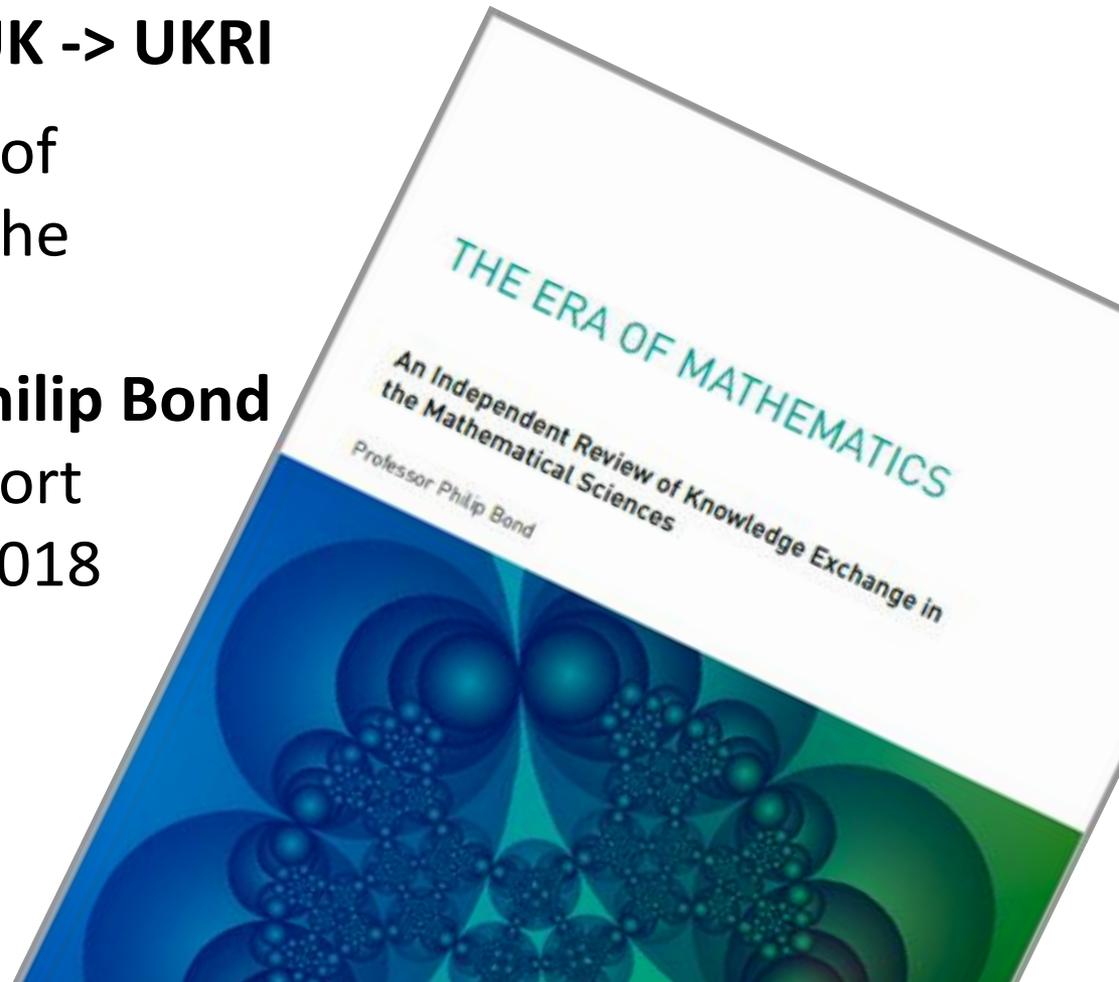
## So, key questions:

- What are the optimal ways to continue to support the community?
- How should we expand (what areas and how is this to be funded)?
- How will the community respond to the continuing need to ensure impact?
- INI/Gateway/ICMS have exceptional convening power – how do we exploit this?
- How do we ensure that we engage with and deliver to stakeholders (industry, government etc)?

# Confluence of Opportunities

## A number of important recent(ish) developments

- **ISCF, GCRF, SPF and RCUK -> UKRI**
- ‘An Independent Review of Knowledge Exchange in the Mathematical Sciences’  
authored by Professor **Philip Bond**  
and an enthusiastic support  
team, and published in 2018
- **£300m additional  
funding for MS**



In recent years, INI, ICMS and KTN have combined their efforts, to assist the community towards working on collaborative large-scale problems and challenges

- Global Challenges Research Fund (GCRF)



- meetings at ICMS in early 2018 and late 2020, with two EPSRC mathematical sciences GCRF funded calls:

“Tackling global development challenges”

“Building capacity to tackle global development challenges”

- Industrial Strategy Challenge Fund (ISCF)

- meeting at ICMS in early 2019 set the direction of travel

- Strategic Priorities Fund (SPF) Bid
  - Submitted end 2018 aimed at enhancing the KE capacity of the UK MS
- INI Strategic Workshops on “Innovative Mathematics for the Modern Industrial Strategy” with Knowledge Transfer Network (KTN) held early 2020:
  - “Physical modelling for formulation”
  - “Network theory and optimal control for the circular economy”
- Formulation Science worked into a full proposal and now held by EPSRC in their ‘Big Ideas’ bank
- Gateway/ICMS now supporting European Study groups with Industry (ESGIs - Gateway 2019, ICMS 2020) and running Modelling/Grad Camps (ICMS since 2016, Gateway 2021)

- **£300m additional funding for MS over 5 years:**

...” ambitious government investment ... to fund experimental and imaginative mathematical sciences research by the very best global talent

....

This funding will make sure the UK remains at the cutting edge of maths research, underpinning real-world technological developments, from smoother traffic flow, crime prevention, safer air travel, and smarter phone technology to the use of artificial intelligence and creating greener energy systems.”

- **£10m to Isaac Newton Institute and £5m to ICMS**
  - How to use some of this for KE? Well ... back to Bond ...

## FULL LIST OF RECOMMENDATIONS

### GOVERNANCE – recommendations for the entire mathematical sciences community

1. An Academy for the Mathematical Sciences should be established in order to facilitate links between academia, government and industry. The Academy should act as the focal point and coordinating centre for the community and draw on the deep expertise of the existing learned societies.
2. The means to structure, streamline and raise awareness of the existing KE support mechanisms that are available should be generated.
3. Existing mechanisms for knowledge exchange (KE) initiation should be made more robust and expanded in scope and capacity. Mechanisms should be put in place that make it straightforward for both industry and academics to find appropriate expertise.
4. Awareness should be raised within the mathematical sciences community of wider research challenges and societal challenges (including the sustainable development goals addressed by the Global Challenges Research Fund, GCRF) and deeper integration of mathematics should be promoted within industrial challenges (including the Industrial Strategy Challenge Fund, ISCF).
5. A more systematic and coordinated approach needs to be adopted to make new and maintain existing KE contacts and to track the outcomes and impacts of KE activities.

## NATIONAL RESOURCES & INFRASTRUCTURE – recommendations for new funding and infrastructure

13. To counter the underfunding of the MS research pipeline and adequately underpin MS in the UK, UK Research and Innovation (UKRI) should look to at least triple the funding going to MS across multiple Research Councils, including but not limited to EPSRC and Innovate UK.
14. A national centre in impactful mathematics for the UK should be created to work with industry and government to drive mathematical research through to commercialisation. This could be based on existing models, such as the Fraunhofer Institute for Industrial Mathematics in Kaiserlautern or the UK Catapult network, suitably modified to provide national-level integration of low-TRL research from universities and to act as a national KE hub.
15. There should be at least one national centre, based on the Heilbronn Institute model, to better enable mathematicians focused on fundamental research to engage directly with government and/or industry.
16. Resources for workshops with industry should be broadened and increased. In particular the Mathematical Study Groups with Industry should be expanded in scope.
17. Strong incentives should be put in place for cross-disciplinary work between the mathematical sciences and other disciplines.

# The Expanded INI/Gateway

- Ensuring ED&I in all that we do
- Embedding sustainable mechanisms for engagement
- Much more training, including breaking down barriers
- Local:
  - three full-size programmes in parallel
  - Continuing expansion of Gateway and one-off events calendar (with partners)
- **INI+** and **Gateway+**:
  - Greater scale of ‘other’ activities ... especially satellite workshops taking place around the UK
  - Novel **satellite programmes**
- Connected-centres KE network
- Supporting the community: National Academy, forums, building critical mass

## Creation of a national Mathematical Sciences Connected-Centres KE Network (CCN)

- Proposition: a scalable and flexible CCN for fostering and supporting KE across all UK mathematical sciences departments
- Working proposal: INI Gateway and ICMS to serve as the nexus, and organise the setting up of some six regional centres or nodes

Together create:

- a set of local partners/satellites (university MS departments)
- a comprehensive schedule of activities
- a shared technology platform
- INI will support a CCN Manager + CCN Assistant to set up network: help establish nodes, a Board, and initial programme of activities across Network
- Long-term aim of nodes attracting substantial local and national funding

# Suggested CCN Roles/Activities

- Connect all nodes and satellites; establish website and comms team
- Promote sharing of information of local and national KE activities
- Establish an events programme and facilitate engagement (via virtual mechanisms as well as face to face)
- Create formal and informal communications routes between KE Facilitators/CC Network Correspondents
- Establish team of super-facilitators to help find/scope/broker interactions with others outside MS, especially industrial partners
- Forge confederations and reach critical mass through national linkage
- Embed ED&I within KE training (ECR to CPD), sharing of good practice
- Strengthening partnerships both inside (eg ATI, IMA, ORS) and outside
- Help bridge communities through internships, springboard fellowships etc.
- Collation of case studies, impact reports, SG reports, videos and podcasts

# Questions and Issues

- Is the suggested structure above the right one?
- What is in it for the nodes and satellites?
- Business model ... who pays who, and for what? What are the aspirations, ambitions, desires of the various stakeholders?
- How do we get buy-in and collaboration from/with the whole MS community?
  - Existing KE centres of excellence in math departments (Oxford, Lancaster)
  - Small places with no track record
  - Learned societies and their existing activities (IMA, ORS, RSS, LMS)
  - Other institute involvement ATI, HIMR, Clay (+ KTN, Catapults ...)
  - Specialist consulting houses for higher TRL translation (Smith Inst., PA Consulting)
  - Organisations, especially with large MS teams (BAESystems, Microsoft, Google, DSTL, GCHQ, NPL ...)
- Require buy-in from other disciplines to assist/share (and their infrastructure)
- Require buy-in from industry, business, commerce, govt. bodies, NGOs ...
- Local versus National priorities
- How do we put coordinated bids together, and what is the ask?
- Do we need an independent Academic Director + ... (& their relationship to INI/ICMS)?
- Role of Gateway and ICMS KE arm long term vs an independent CCN?
- What are the mechanisms to be employed (internships, (V)SGs, KEFs, w'shops, brokering ...)?
- What is our path to achieve this steady-state vision? And CCN vs a National Academy?