The 5th IAWN Steering Committee Meeting took place on the margins of the Scientific Technical Subcommittee (STSC) of UNCOPUOS on 30 January 2018 in Vienna, Austria. Shortly after beginning the meeting and introductions, the IAWN agenda was adopted.

There are now five (5) new signatories to IAWN. These include the Crimean Astrophysical Observatory (http://crao.ru/ru/); the Kourovka Astronomical Observatory of the Ural Federal University (http://astro.ins.urfu.ru/kourovka); the Special Astrophysical Observatory of the Russian Academy of Sciences (http://www.sao.ru/Doc-k8/); the Institute of Solar-Terrestrial Physics, Russian Academy of Sciences (http://en.iszf.irk.ru/Main_Page); and, the China National Space Administration, CNSA, (http://www.cnsa.gov.cn/n6443408/index.html) also signed the IAWN Statement of Intent. The IAWN Steering Committee welcomes the new signatories and looks forward to future contributions.

IAWN status was provided by INASAN, KASI, ESA, NEODyS, ESO, INAOE, NASA and JAXA. The presentations provided are posted to the IAWN webpage.

INASAN

Boris Shustov presented an update on Russian activities (including the four new signatories to IAWN). The 2-meter Zeiss telescope at Terskol Observatory aided in the international efforts in the recovery of 2012 TC_4 by providing follow-up astrometry on this near-Earth asteroid (NEA).

Further details were also provided on two INASAN telescopes. Zvenigorod Observatory (http://www.inasan.ru/en/divisions/zvenigorod/about_zo/) is currently commissioning a 1-meter aperture telescope, designed for 10 x 10k CCD, 3° field-of-view (FoV), and has a limiting magnitude of ~21.5. There is also a 1-meter telescope (a Zeiss-1000) at Simeiz Observatory on Mt. Koshka, Crimea, that has a 4 x 4K CCD, 1° FoV, and limiting magnitude of ~20-21. Both telescopes are part of INASAN's optical network. Should there be an observing campaign (perhaps resembling the 2012 TC_4 recovery and follow-up effort last year), the additional suite of observatories:

- Special Astrophysical Observatory (RAS) – 6.0-m telescope
- Crimean Astrophysical Observatory – 2.6-m telescope; 0.8-m wide-field telescope
- Ural Federal University (Ekaterinburg) – 1.2-m telescope
- Kazan Federal University – 1.5-m telescope (in Turkey)

could very well be utilized in an observing campaign (whether it be an asteroid recovery effort or pursuant to an IAWN warning).

KASI

Hong-Kyu Moon (KASI) shared and presented an update on the Korea Microlensing Telescope Network (KMTNet http://kmtnet.kasi.re.kr/kmtnet-eng/). The KMTNet is comprised of three identical 1.6-m positioned approximately in equidistant longitudes in the Southern Hemisphere (near Siding Spring Mountain on Mt. Woorat, New South Wales, Australia; the Cerro Tololo Inter-American Observatory near Cerro Pachón, Chile; and the South African Astronomical Observatory near Cape Town, South Africa). All three facilities are roughly at the same latitude (i.e., ~ 30° south).

The KMTNet is optimized to conduct gravitational microlensing surveys. As such, detections of low-mass exoplanets (i.e., Earth-mass planets in the habitable zone or the recent discovery of the Earth-mass 'ice world' OGLE-2016-BLG-1195Lb) that are inaccessible by other ground-based techniques. In addition to the primary science, it is possible to conduct a variety of other observational programs with the KMTNet system, including photometric studies of nearby galaxies and galaxy clusters, discovery of supernovae and their follow-up observations, and observations of near-Earth objects.

Each telescope in the system has 18 x 18k CCD, 4° FoV, with a resolution of 0.4 arc-seconds/pixel. Several light curves on several NEAs were shared (demonstrating the capability of all KMTNet telescopes (at CTIO, SSO, and SAAO). One asteroid of interest that was shared was 5247 Krylov [a Main Belt] in which the photometric light curves from the KMTNet over the course of 51 nights show that Krylov is a non-principal axis rotator. Results are published in the *Journal of the Korean Astronomical Society* **50**:3 pp. 41-49 (2017).

KTMNet was also engaged with the recovery of 2012 TC_4 by providing follow-up photometry from the SSO and SAAO sites.

ESA

Detlef Koschny (ESA) presented and discussed the current layout of ESA's SSA page (link here http://neo.ssa.esa.int/).

NEODyS

Giovanni Valsecchi (IAPS-INAF) updated of the future of the NEO Dynamics Site (NEODyS) website at the University of Pisa and NEO utility to the Steering Committee. His presentation provides an overview of NEODyS' creation and history. The website is a resource to the NEO community for identifying impact candidates, utilizing standard distribution orbit-fit software (OrbFit) in conjunction with additional software for "scraping" data from various publically available internet sites. The site will be retired at the end of October 2018. While much of the software and functionality will be migrated to the NEO Coordination Centre (NEOCC) of ESA, the details of how this transfer will occur, along with the transfer of expertise that has been developed by NEODyS, are being worked out presently.

ESO

The European Southern Observatory (ESO) was founded in 1962. There are currently 15 members (with Ireland slated to join in 2018). While all ESO's observatories are located in Chile, it is headquartered in Garching, Germany. Andy Williams (ESO) presented and discussed the ESO/ESA cooperative agreement for Followup for faint objects (i.e., V_{mag} of 23 down to 27) under ESA's Space Situational Awareness NEO program. Astrometric follow-up for newly discovered objects such as 1I/2017 U1 ('Oumuamua) or the follow-up and recovery of faint threatening NEOs (as was accomplished with the 8.2-m VLT and 2012 TC_4).

INAOE

José Ramón Valdés presented the INAOE (Instituto Nacional de Astrofísica, Óptica y Electrónica) progress on NEO spectroscopy, part of a project that has acquired spectra for over 150 asteroids for the purposes obtaining their taxonomic classification. A total of 54 NEAs have been reduced and classified, or had their taxonomies constrained, using spectra spanning the 420 to 950nm wavelength range. The spectra were taken at the Observatorie Astrofysico Dr. Guillermo Haro (OAHG) 2.1-meter telescope. Further data will be obtained using nine allocated observing nights in 2018.

JAXA

Makoto Yoshikawa (JAXA) presented the update of JAXA activities to the IAWN. Though he mentioned the *Hayabusa2* mission and its anticipated encounter with (162173) Ryugu in June, he referred to his presentation at the SMPAG the following day for further details, and proceeded with a discussion of other JAXA activities. The focus was on the use of smaller aperture telescopes to search for NEOs, which utilized track-and-stack methodologies to mitigate confusion noise source contributions through median filtering techniques and boost faint object signal to successfully discover two PHAs (2017 BK and 2017 BN_{92}) in January of 2017. The effort was undertaken with National Astronomical Observatory of Japan and Japan Spaceguard Agency using 35cm and 18cm telescope diameter assets.

NASA

Rob Landis (NASA) provided an update on NASA's activities over the past year, beginning with the NASA-funded surveys: the Catalina Sky Survey (CSS), Pan-STARRS, SST/LINEAR, NEOWISE, and a relative newcomer – Asteroid Terrestrial-impact Last Alert System (ATLAS). The Lincoln Near-Earth Asteroid Research (LINEAR) is in the process of being re-located to the Holt Naval Communication Station in Western Australia and be reassembled. The SST should be operational again in 2020 and provide southern hemisphere coverage of the sky.

NEOWISE will continue operations into mid-2018. It was brought out of hibernation in late-2013, resuming its search for minor planets on 23 December 2013, operating in 'warm' mode at

3.4 and 4.6 microns. As an infrared survey, NEOWISE detects asteroids based on their thermal emission and is equally sensitive to high- and low-albedo objects; consequently, NEOWISE-discovered NEOs tend to be large and dark and provides accurate diameters of detected objects.

NASA has funded the development of the ATLAS system and is comprised of two sites in Hawaii: ATLAS1, on Haleakalā, became operational in late 2015 while ATLAS2, on Mauna Loa, began operations in March 2017. The two sites are 158 km apart, automatically scanning the sky several times every night. Its rapid cadence (~1 hour between visits) can capture asteroids relatively close to the Earth. ATLAS complements the aforementioned surveys described above.

ATLAS couples a 0.5-meter (*f*/2 Wright-Schmidt system) aperture with a 110 megapixel CCD camera. The field of view is 7.4°; exposure times are 30 seconds (plus 5 seconds of readout) and can reach V_{lim} of 20.

Survey statistics, number of NEO discoveries to date (i.e., > 17,500 NEOs have been catalogued; > 2,000 discovered in 2017!), with 1,887 PHAs and 107 NECs).

The recovery of 2012 TC_4 was also briefly mentioned. The primary goal in recovering 2012 TC_4 was to exercise the planetary defense system and utilize the IAWN interfaces. As Andy Williams mentioned near the start of this IAWN meeting, ESO's 8.2-meter VLT recovered (and later confirmed) the recovery of 2012 TC_4 at V_{mag} of ~27, the faintest asteroid recovery ever. Further characterization from photometric, spectroscopic, and radar followed later. Additionally, modeling -- as it pertains to orbit determination, threat assessment, and impact exercises.

3122 Florence was imaged by NASA's planetary radar with both Goldstone and Arecibo assets. Discovered by Bobby Bus in 1981, Florence is fourth (4^{th}) in size of large PHOs (at ~5 km in diameter) and came within 0.047 AU of the Earth on 1 September 2017. The radar imagery revealed two moonlets orbiting Florence. The inner moonlet is ~180 to 240 meters across with a period of revolution (around the main body) of 7 hours. The outer moonlet measures 300 to 360 meters with an orbital period of 21 to 23 hours. The IRTF spectral data shows the asteroid bears a striking resemblance to the meteorites recovered from Chelyabinsk. Florence is the third known trinary system amongst the NEO population.

The PDCO is currently funding three flight mission projects: NEOWISE (in Sun-synchronous orbit; expected to continue operations through summer 2018); NEOCam (continues in an extended Phase A); and DART (Double Asteroid Redirection Test, in Phase B).

Wrapping up, the NEO Survey Science Definition Team Report's findings were shared. These are:

> **Finding 1**. Future goals related to searching for potential Earth-impacting objects are best stated explicitly in terms of the statistical risk characterized and should be firmly based on cost/benefit analyses. Such a search would best be executed in a way that eliminates the maximum amount of statistical risk uncertainty per dollar of investment.

> **Finding 2**. It would be most productive to develop and operate a NEO search

program with the goal of discovering and cataloging the potentially hazardous population sufficiently well to eliminate 90% of the uncharacterized risk from sub-kilometer objects (i.e., sub-global impact effects). Over a period of 9 to 25 years, a number of system approaches are capable of meeting this search metric with quite good cost/benefit ratios.

Finding 3. The satisfaction of the 140-meter cataloging objective will require space-based search system(s). Infrared (IR) and visible sensors in the 0.5- to 1.0-meter aperture range are credible and cost/benefit-favorable options that use available technology.

The full report is available here:

https://www.nasa.gov/sites/default/files/atoms/files/2017_neo_sdt_final_e-version.pdf

New IAWN Webpage

James "Gerbs" Bauer of the University of Maryland reported on a new website for the IAWN. The website is a key facility of communication amongst the members of IAWN as well as the observing community and the public in general (c.f. Billings 2015). The website will be functionally relocated to the University of Maryland (UMD), although the current web address (iawn.net) will point to the new UMD website. UMD is the home of the NASA Planetary Data System's Small Bodies Node, responsible for data concerning asteroids and comets. As of January 2017, UMD began oversight of the Minor Planet Center as a sub-node of the SBN and so maintains unfettered communications with the MPC. NEO Sciences LLC CEO, Tim Spahr, a founding member of the IAWN Steering Committee now also has a sub-award with the SBN to help in overseeing the MPC and in managing the IAWN activity. UMD has experience organizing data collection and distribution for worldwide observing campaigns, including recently the 12 October 2017 close approach observing campaign of 2012 TC_4, in part for IAWN.

A mock-up of the website is located at http://www.astro.umd.edu/openhouse/TEST/ . The intent is to offer a more compartmentalize format with easier access to the desired information, and to serve as a key NEO community resource. In addition to meeting minutes and logistical information, and the links to new close-approach discoveries available on the present site, the new site will host regular feature articles on the NEO observation effort as well as generate orbit and viewing geometry information for each close-approaching NEO. As the number of discovered close-approaching NEOs continues to increase, the new website should facilitate a proportionate follow-up response to adequately characterize these new candidates and position IAWN to process and react to the stream of data from upcoming surveys.

IAWN Report to STSC

The IAWN (annual) report to STSC was discussed and later reviewed the following day (at the end of the SMPAG meeting). Lindley Johnson presented the IAWN technical brief to the STSC while Rob Landis later read the annual report and submitted to STSC.

Joint IAWN/SMPAG Action Items

There are two SMPAG action items that require IAWN inputs; notably, SMPAG action items 5.1 Criteria/Thresholds for Impact Response Actions and 5.6 Communications Guidelines in the Event of a Credible Threat.

5.1 was agreed upon at the previous IAWN gathering in Pasadena, California, in November 2016. SMPAG concurred and accepted the Criteria/Thresholds at its meeting in February 2017. Rationale language has also been provided for these criteria.

5.6 is more involved and attempts to describe the guidelines and communication(s) chain(s) IAWN will follow in the event of a credible threat. In a nutshell, it can be broken down into four primary points:

- If an object (10-meters or greater in size has a 1% or greater probability of impact), IAWN shall warn of the pending impact on the IAWN webpage (http://www.iawn.net) and JPL sentry page (http://neo.jpl.nasa.gov/risks). One page description suffices.
- if such an object is on impact trajectory, NASA's Center for NEO Studies (CNEOS) and ESA's Near-Earth Object Dynamic Site (NEODyS) shall independently prepare appropriately relevant maps of the Earth impact sites with time of impact
- Content of the page
    - Designation
    - Facts (discovery, size estimate, composition)
    - impact location
- IAWN spokesperson informs UNOOSA
- UNOOSA informs appropriate entities and Member States of the credible threat

The steering committee agreed as to how the general notification alert should appear. (See the example in the charts.) However, in such an event or scenario, a central IAWN spokesperson is not perhaps the best method to inform UNOOSA and beyond. A minimal quorum of international experts needs to convene and concur upon the warning language. Then, in turn, SMPAG (and UNOOSA) is informed. The details of that communications chain(s) remains to be finalized. Further discussion (and finalization) on 5.6 was tabled until the next IAWN steering committee meeting this coming autumn.

Coordination of IAWN-relevant Information in the EU and NATO

The question on how non-national entities would be informed (e.g. EU, NATO) came up. The NASA representative explained that in case of an impact warning, the US NATO representative would be informed via their national monitoring and command center.

UN-SPIDER: Technical Advisory Missions, Global Network, Future Cooperation

Shirish Ravan (UNOOSA) presented information on UNOOSA's program – United Nations Platform for Space-based Information and Emergency Response (UN-SPIDER). The program resulted from recommendations by UNISPACE III conference and in 2006, the General Assembly mandated UNOOSA to establish and implement UN-SPIDER.

UN-SPIDER has a relatively simple, succinct mission statement:

> *... [to] ensure that all countries have access to and develop the capacity to use all types of space-based information to support the full disaster management cycle.*

UN-SPIDER has three primary offices: Bonn, Germany; Vienna, Austria; and, Beijing, China. Its work and dissemination of information is supported by its knowledge portal at http://www.un-spider.org/ as well as by working with a network of twenty-one Regional Support Offices globally.

UN-SPIDER's role is more aligned with supporting the full cycle of disaster management and strengthening capacities of countries in that regard, which also includes emergency response actions (following a disaster event). For IAWN – it could both serve as both in the outreach/situational awareness role [as to IAWN functions] but, also for emergency preparedness and emergency response.

Possible areas of cooperation were discussed. Due to several commonalities addressed at PDC (disaster preparedness), UN-SPIDER representative was also invited to PDC 2019 by IAA.

Actions:

- IAWN to provide UN-SPIDER information on its work to be distributed through UN-SPIDER newsletter and its Regional Support Offices globally to reach more Member States and raise awareness about IAWN's role in case of a potential threat (link to disaster risk reduction communities). Time-line: by mid-March, maximum 1 page/one image.
- A NEO-module could be developed and included as part of UN-SPIDER technical advisory missions on preparedness and emergency response. Time-line: Over the course of couple of years, providing resources/some funding support.

UNISPACE+50

On 20 and 21 June 2018, UNISPACE+50 will convene in Vienna in a special segment of the 61st Session of UNCOPUOS. IAWN and SMPAG will prepare an illustrated pamphlet ~4 to 6 pages, showcasing near-Earth asteroids (and comets) and the activities of IAWN and SMPAG. Hong-Kyu Moon shared a draft version of how this brochure might appear. Sergio Camacho has graciously agreed to write the initial draft. Detlef Koschny and Rob Landis will work with UNOOSA and Romana Kofler for relevant imagery.

Next IAWN Gathering

We agreed that the next IAWN Steering Committee meeting should occur in the coming autumn. Later in the week at the SMPAG meeting, it was agreed to hold both the next IAWN and SMPAG meetings on the margins of the DPS conference (21 – 26 October 2018) in Knoxville, Tennessee. Topics for the next IAWN agenda include: composition of the Steering Committee; completing SMPAG Action Item 5.6; results from UNISPACE+50.