Definition
There has been a recent renaissance of interest and investment in deploying high-data-rate communications networks based on constellations of 1000’s of Low-Earth-Orbit (LEO) satellites, as well as suborbital communications platforms such as High-Altitude Long Endurance (HALE) aircraft, persistent UAVs, airships, etc. These networks will have global impact on humanity by delivering ubiquitous high-bandwidth communications to nearly 60% of the world’s population that lives in underserved and fast-growing, but hard-to wire, regions of the world, maintaining such communications during natural or manmade disasters, with modest investments in ground infrastructure, and serving as a critical backbone for the Internet of Things (IoT). In the more distant future, these space-based networks may extend to serve manned and unmanned space missions throughout the solar system. We refer to these emerging networks as the Internet of Space (IoS).

Here is an alternative description, based on Robert’s presentation

Today, many Companies are entering the Space Business, especially the LEO-based Business. For example, SpaceX, OneWeb, Google and Facebook are presenting their World Scale Plans for Space. SmallSat Businesses plan to deploy Large Constellations of Tens, Hundreds and even Thousands of Satellites, the majority of which shall be in LEO Constellations to achieve Low Latencies. The Space Industry is facing Disruptive Changes, on a Massive Scale, which has not been seen since the original Space Race in the 1960s!

This area cuts across multiple hardware-oriented fields of interest including: aerospace systems; antennas; autonomous systems; communications; electronics; microwave/mm-wave technology; photonics; positioning, navigation and timing; power electronics, etc. From space, broadband connectivity to aircrafts and ships will be available within 1 to 3 years, to the entire globe in 3 to 5 years and to other planets (moon, Mars) within 10 to 20 years.

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For example, Google and SpaceX recently announced a $B investment in a plan to deliver hundreds or thousands of micro satellites into LEO around the globe to serve Internet to rural and developing areas of the world. SpaceX’s ultimate goal is building a bridge to a future manned colony on Mars. Similarly, a new venture, OneWeb, is proposing a 648 satellite LEO constellation, with significant investments from Virgin Group and Qualcomm. Facebook and Google already have begun laying plans to serve under-wired markets with drone-based and balloon-based data networks. The European Space Agency and AirBus Defense & Space are planning a “Space Data Highway” that features EO satellites at GEO, and a set of LEO satellites to provide a hybrid optical / RF network for Emergency Response, Open Ocean Surveillance, UAS communication, Weather Forecasting and Wide-Area Monitoring on the impacts of human activities on state of natural resources (deforestation, loss of biodiversity, water/air pollution). The Space-based networks represent the final frontier in the competition for connectivity.

Back in the 1990’s, there were a number of large space-based satellite network ventures, such as Iridium, GlobalStar, Teledesic, etc. but only limited number of low-data rate (kbps) satellites were ultimately deployed. However, since that time, satellite technology has greatly advanced, bringing the cost of deployment down significantly. “Toaster-sized” micro-satellites can be launched dozens at a time to low earth orbits (LEO), reducing launch costs, while delivering performance comparable to larger, older satellites at higher orbits. Also, operation at LEO, satellites will also significantly reduce network latencies, while introducing challenging tracking, synchronization and handoff issues. Advances in microwave/mm-wave phased array technology and advanced CMOS over the last several years will also be key enablers. The new networks should not be expected to replace terrestrial networks, but will integrate seamlessly with these networks to provide ubiquitous global connectivity.

The design, implementation, and operation of the proposed space-based information networks will require highly interdisciplinary teams of researchers and engineers cutting across a range of IEEE hardware (and software) oriented societies, councils and other OUs. Key technologies for such systems include:

- Small and micro- satellite design
- Unmanned Aerial Systems
- Space, air, and ground network architectures and protocols
- Microwave/mm-wave transceivers, antennas and phased arrays
- Satcom terminal equipment – handsets, airborne and nautical
- System-on-a-chip (SOC) devices for mobile SATCOM
- Free space optical links
- Inter-operability/Connectivity to terrestrial networks (4G/5G mobile and IoT)
- Dynamic Spectrum management
- Coding and digital signal processing
- Timing and synchronization
- PV and nuclear power sources/power electronics
- Radiation-hard electronics
- 3D printing of electronics and structures

Engaging IEEE OUs
In addition to MTT-S, the following IEEE OUs are expected to play a critical role in the future development of the Internet of Space:
- Aerospace and Electronic Systems Society (AESS)
- Antennas and Propagation (AP-S)
- Communications Society (ComSoc)
- Electromagnetic Compatibility Society (EMC-S)
- Geoscience and Remote Sensing Society (GRSS)
- Photonics Society
- Power Electronics Society (PELS)
- Solid State Circuits Society (SSCS)
- Standards Association
- Sensors Council
- Systems Council
- Vehicular Technology Society (VTS)

MTT-S has already engaged AP-S and EMC-S in the IoS initiative in conjunction with a recently executed Sister Society agreement. Outreach to AESS, ComSoc, GRSS, Systems Council and VTS is currently in progress at the Society President level.

Recent Activities
- An IoS webpage has been created under mtt.org: https://mtt.org/internet-space-initiative-ios
- An IoS initiative planning workshop was held in conjunction with IEEE MTT-S Radio and Wireless Week on Jan. 25th 2016 in Austin, TX. Over 40 participants from industry, academia and government, both US and international, were involved in the workshop, including representatives from AP-S (AP-S President and the APS FDC Chair) B. Hoang gave a presentation on the IEEE FDI program. Three technical talks were presented and a total of 7 breakout groups worked tasks. One breakout group identified speakers for future conferences and webinars.
- A rump session entitled “The Internet of Space – Technological and Economic Challenges for the Future Space-based Internet” is being planned for the evening of Tuesday, May 24th during the 2016 IEEE International Microwave Symposium (IMS) in San Francisco, CA. The panel will consist of senior leaders from this emerging Internet of Space industry who will discuss the technical and economic issues surrounding the large-scale deployment of these commercial internet systems. Panelists will be drawn
from companies and organizations such as: Google/SpaceX, OneWeb/Qualcomm, Facebook, Boeing, Airbus, Viasat, etc. The rump session will be followed by a networking reception. The rump session will leverage the proximity of IMS2016 to the Silicon Valley ecosystem that is driving several of these commercial space-based internet ventures, and engage a technical community beyond the traditional IMS attendees. A dynamic, free-flowing discussion is anticipated, carrying over into the reception.