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Interoperable GNSS SSV Video Status and Recommendations

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Today's Purpose

Provide update on SSV video development

- Recap of video takeaway and audience
- Changes in video planning and content, based on NASA Office of Communications and Video Producer comments
  - Maximum length of video
  - Script changes
- Status on international video clips
- Video production status & tentative schedule for roll-out

SSV Video Length

- Research findings* illustrate need to keep video short
  - Humans have short attention spans
  - Engagement decreases with video length
- NASA video experts confirm findings; feel < three minutes is best for SSV type videos
- **SSV video goal**-- three minutes; current (reduced) script about 3.5 minutes long

*https://wistia.com/blog/optimal-video-length

SSV Video: Audience

- Video directed towards a general audience
- Seasoned aerospace engineers really don't understand how GNSS works, so they fit into a general audience
- US candidate audience includes:
  - US Congress
  - Senior executives in NASA and OGAs
  - Other decision makers
  - Plus…international audience
- International candidate audience includes:
  - UN COPUS
  - Senior Leaders in international space agencies
  - GNSS constellation providers
  - Space scientists
  - Space exploration experts
  - Satellite developers, especially spacecraft at GEO

Video Takeaway

Individual Global Navigation Satellite System (GNSS) constellations in the Space Service Volume (SSV) have demonstrated outstanding operational and societal benefits but they supply insufficient available signals to fully support future missions

An interoperable, specified Multi-GNSS constellation capability in the SSV is critical for the continuous coverage required to support future beyond-low-Earth orbit missions that a single constellation cannot provide

Video Script Content

Expanding Navigation Use in Space

- Introduction
- GNSS Overview
- SSV Overview
- SSV Application Advantages
- SSV Interoperability Advantages
- UN ICG—an SSV interoperability enabler
- Conclusions

Script-- Introduction

- You probably know that your GPS and similar international navigation systems use satellites in space to help you navigate to where you want to go and to support intelligent agriculture, power grids, financial commerce and many other utilities.

- Did you know that those same satellites could be a game-changer for next-generation weather satellites, space exploration and more?

Visuals: Stock GNSS Video

Script-- GNSS Overview

- There are four major global navigation satellite systems (GNSS) with global coverage – the United States' GPS, Russia's GLONASS, Europe's Galileo and China's BDS, as well as regional systems like India's NAVIC system and Japan's QZSS. Operating together, these systems can significantly improve navigation and timing aboard user spacecraft.

- In fact, they make it possible for spacecraft to navigate themselves autonomously, without direction from the ground. This is a major leap forward in navigation technology.

- As a result, the quality of scientific data improves from spacecraft operating at very high altitudes (in a region we call the space service volume).

Visuals: Existing animations of global navigation satellite systems, MMS footage

Script-- SSV Overview

- The space service volume, or SSV, stretches from 3,000 to 36,000 kilometers above Earth, where most of the weather and communications satellites reside.
- In many cases, it is well above the navigation satellite orbits.
- Since the GNSS signals must travel to the other side of Earth to be received by a user spacecraft, GNSS reception in the SSV is very challenging. Earth blocks most of the GNSS signals. The signals are also weaker due to the long distances between the user spacecraft and the GNSS satellite.
- To mitigate these issues, engineers have developed special weak signal receiver hardware and special software to support navigation and timing with only one GNSS signal in view.

Visuals: Animation Showing GNSS Converge on the Other Side of the Earth (backup slides show one example on how to convey this); GNSS Space Receiver Pictures (International Examples)

Script--SSV Application Advantages

- Without this technology, current and future weather satellites would be unable to do things like accurately pinpoint the location of extreme weather.

- This capability is crucial to public safety and effective weather prediction.

- And that's just one of the many uses for GNSS!

Visuals: GOES/International Satellite weather data. Hurricane or typhoon data. Opportunity to show extreme weather in other countries to augment international presence.

Script-- SSV Interoperability Advantages

- Individual GNSS constellations have already demonstrated superb operational and societal benefits on Earth and in low-Earth orbit. This is because users receive lots of GNSS signals at these altitudes. But one constellation alone cannot guarantee full-time reception of GNSS by users that operate in the SSV.

- However, when all GNSS constellations and regional systems operate together, the unified system averages four to 12 signals in view and can guarantee at least one signal in view at all times.

- This is critical to ensure that missions have navigation support 24/7/365.

Visuals: New animation showing the navigation constellations coming online one at a time and the subsequent boosts in coverage—Tachometer Analogy

Script—UN ICG: an SSV interoperability enabler

- So how do we get all these GNSS constellations and regional systems working together?

- The United Nations International Committee on GNSS is leading collaborative efforts to make all these systems interoperable through the creation of common definitions and specifications.

Visuals: Existing UN building footage

Script—Conclusions

- **Once a fully interoperable multi-GNSS Space Service Volume is in place, its outstanding navigation and time-sensing capabilities will provide future innovative opportunities to observe, communicate and work in space.**

- **These capabilities will be critical for both Earth and space weather observations, spacecraft flying in formations, situational awareness in space, and even navigation to cislunar space!**

Visuals: User data, opportunity to use more existing international footage.

Video Development Plan

- Final collection of video clips and high quality pictures from international community
  - NASA received clips/pictures from Europe, NAVIC video from India, and low resolution formation flying video from Japan
  - Video clips and pictures must align with script and planned video content
  - All must be HD video
- NASA currently working with video producer, animators and production unit to develop polished SSV video final draft
- Current script, with ICG-13 WG-B comments, will be employed in video production
- Roll-out of draft video at SSV Task Force meeting
- Finalize video prior to end of year (goal)

Video Clip and Picture Guidance

- Make sure all video clips and pictures align with the script
- Items we would like to obtain include:
  - High resolution (HD) clips with detailed view of your satellite in orbit
  - Videos that match the current script, including current and future prospective missions, like your GEO weather satellite, etc. In other words, satellite users in the SSV
  - Other ideas?
- We would really appreciate your inputs. These will be part of a polished video that we can all use to describe the SSV to many

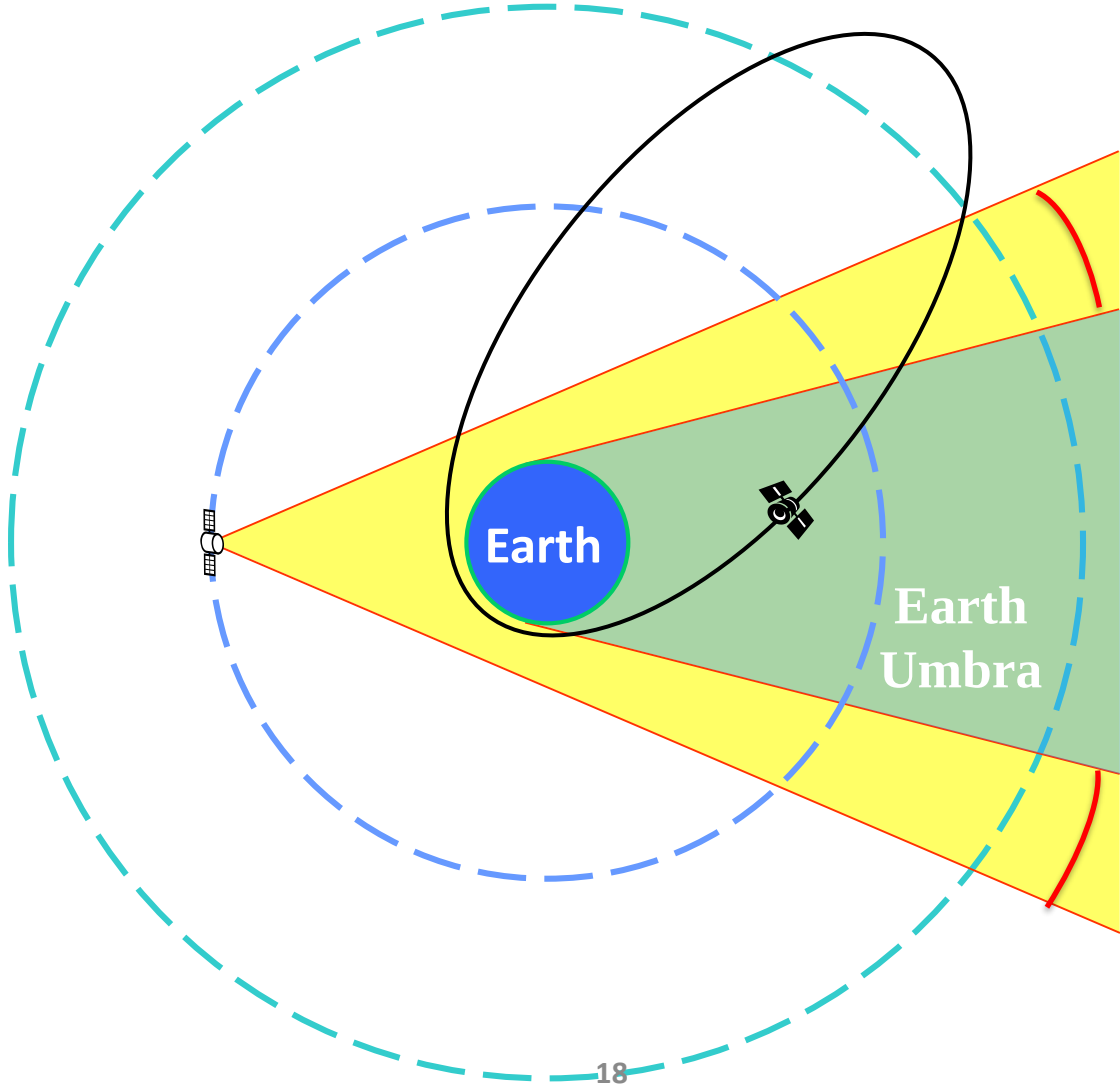
Tentative Schedule

- Finalize script and action plan: ICG-13
- Final video clips due from all parties: November 21, 2018
- Production version draft: Early December
- Final Production copy for review: Late December
- External release: Spring 2019

Backups

How can we describe SSV challenges in just a few seconds

- Since the GNSS signals must travel to the other side of Earth to be received by a user spacecraft, GNSS reception in the SSV is very challenging.
- Earth blocks most of the GNSS signals.



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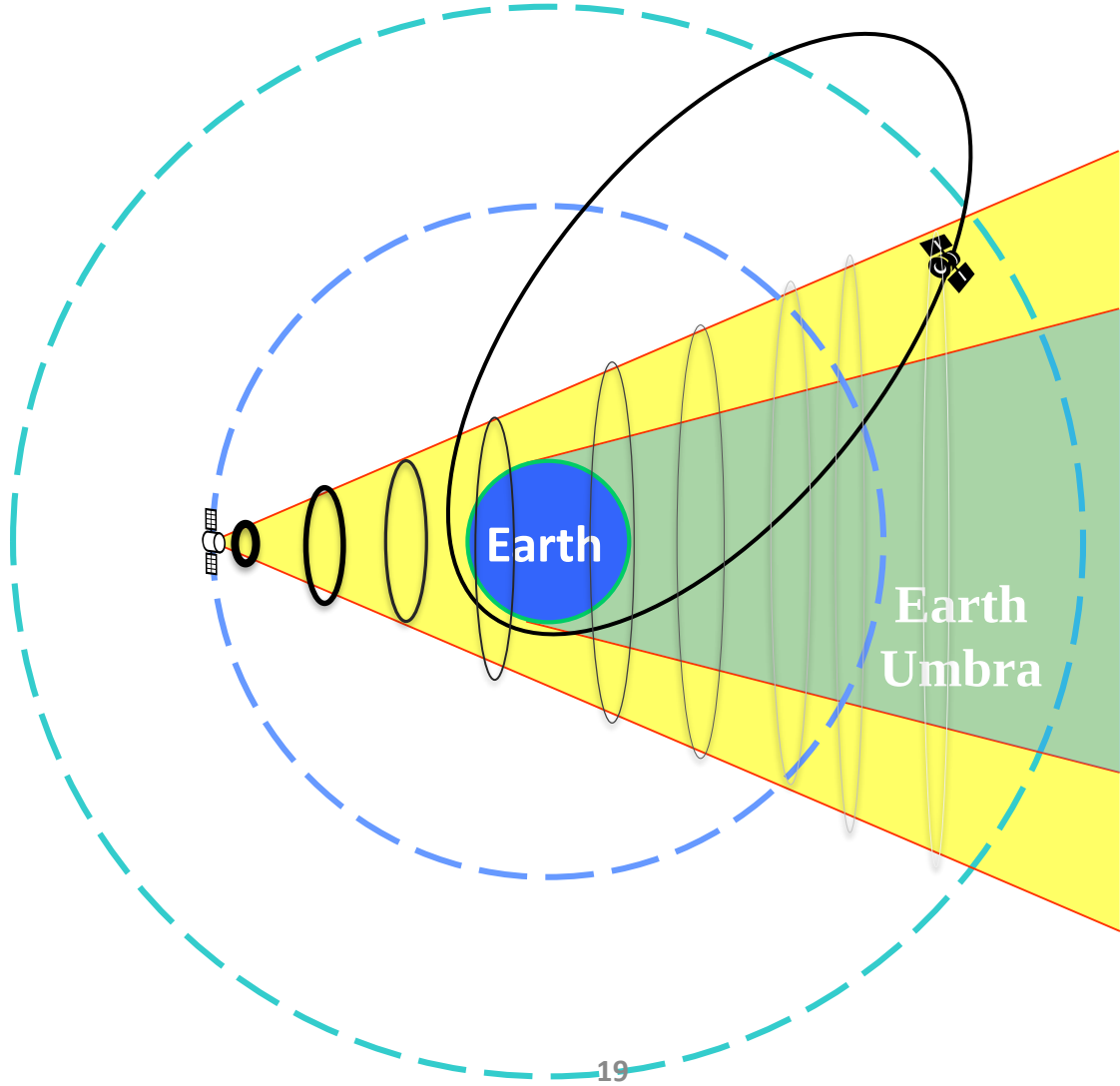
How can we describe SSV challenges in just a few seconds

- The signals are also weaker due to the long distances between the user spacecraft and the GNSS satellite.



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Describing how to overcome the SSV challenges in a few seconds

- Use “tachometer” analogy to represent # signals in view—a key performance metric
  - 0-1 “red” 2-3 “yellow” and 4-12 “green”
  - Tachometer goes from 0-12
- With 1 GNSS constellation at LEO, tachometer hits stops at 12
- As spacecraft traverses from LEO to GEO, tachometer drops precipitously from 12 (green) to 0-1 signals in view (red)
- As multiple constellations are added, tachometer goes from red to green; shows benefits of multi-GNSS