Recent Progress of VGOS and its role on GGOS

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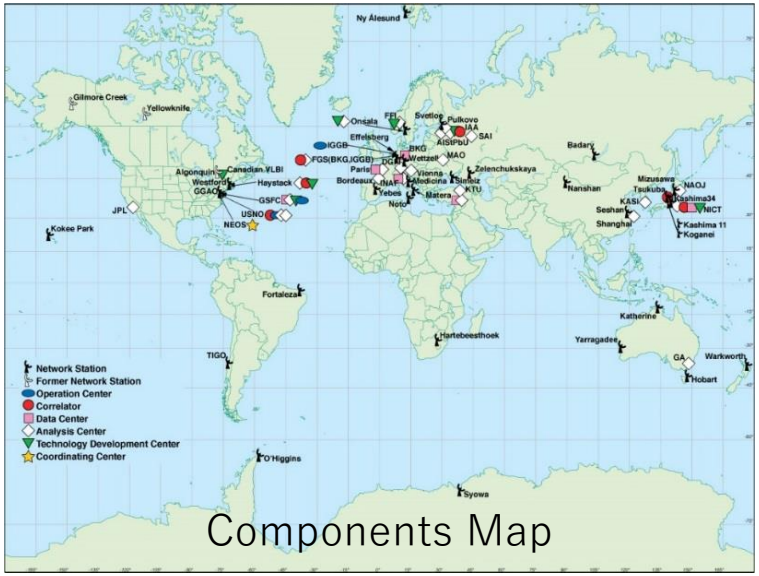
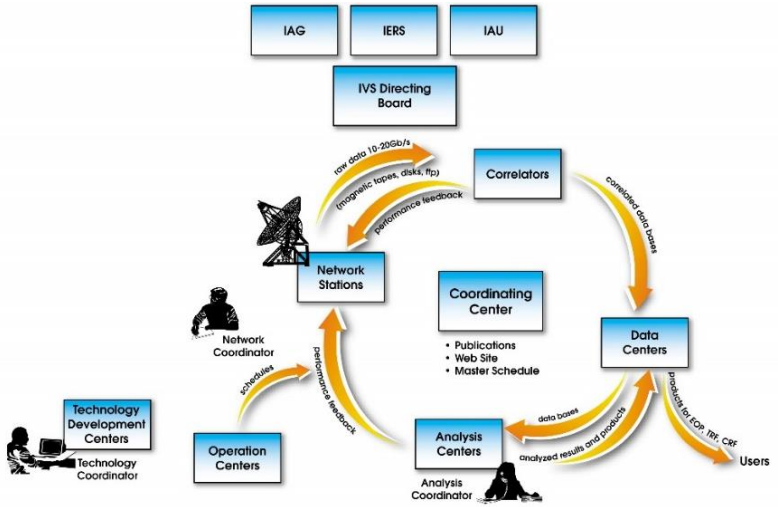
IVS: International VLBI Service for Geodesy and Astrometry

- An international collaboration of organizations which operate or support International Geodetic/Astrometric VLBI
- Established in 1999
- 85 components supported by 43 institutions in 20 countries
- Providing TRF, CRF, EOP products as a service of IAG, IAU and WDS



Components Map



Organization of IVS

VGOS: A New VLBI Observing System

- More accurate estimation of position and velocity
- Sparse observations (2 to 4 times per week)
- Time lag from observations to products

IUGG

IAG GGOS Global Geodetic Observing System

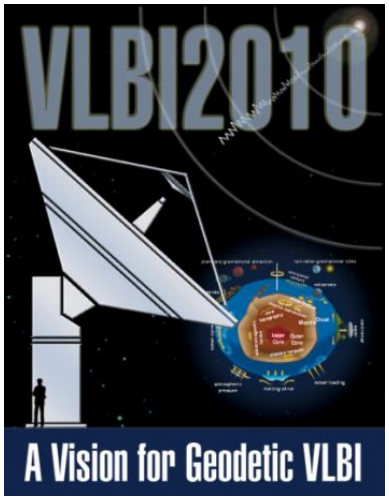
VGOS: VLBI Global Observing System

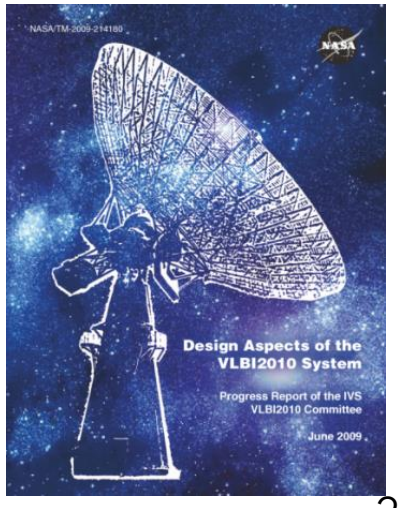
A new VLBI Observing System by IVS to contribute to GGOS

2003～2005
General Concept by IVS WG3

2005～2009
Technical Design by VLBI2010 Committee

2009～
Implementation by VGOS Project Executive Committee





Overview of VGOS

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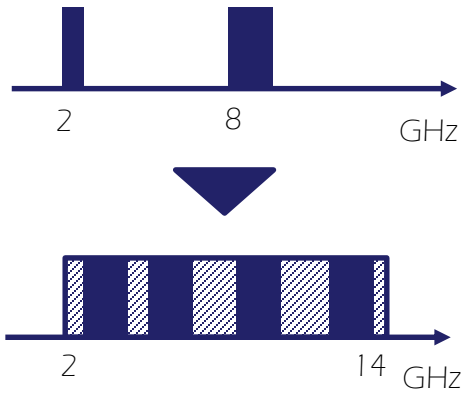
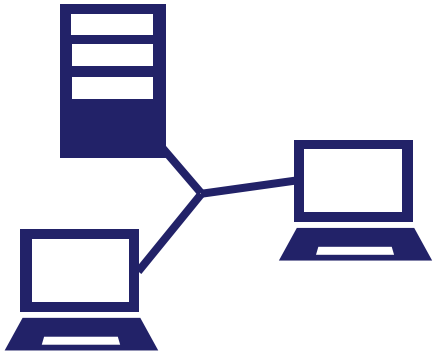
Broadband



Mid-size, Fast-slew Telescope

High-Rate Data Processing



	Freq. Range	Antenna Size	Slew Speed	Rec. Rate
Legacy	2, 8 GHz	5 – 100 m	~ 3 deg/sec	~ 1 Gbps
VGOS	2 – 14 GHz	12 – 13 m	~ 12 deg/sec	~ 32 Gbps

Goal of VGOS

- Accurate pos/vel determination of 1mm, 0.1mm/yr
- Continuous observation of 24/7/365
- Products available with low-latency

VGOS at GSI (Ishioka station)

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Diameter	13.2 m
Slew rate	
Az	12 deg/sec
El	6 deg/sec
Optical system	Ring Focus
Frequency Range	
S/X-bands	2, 8 GHz
Broadband	3～14 GHz

VGOS at GSI (Ishioka station)

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2014 Mar. Antenna Installation

2015 Feb. Test observation with S/X-bands

2016 Feb. Building Installation

May **Regular observation with S/X**

Aug.-Sep. **VGOS Test**

2017 Jan. **UT1** observation

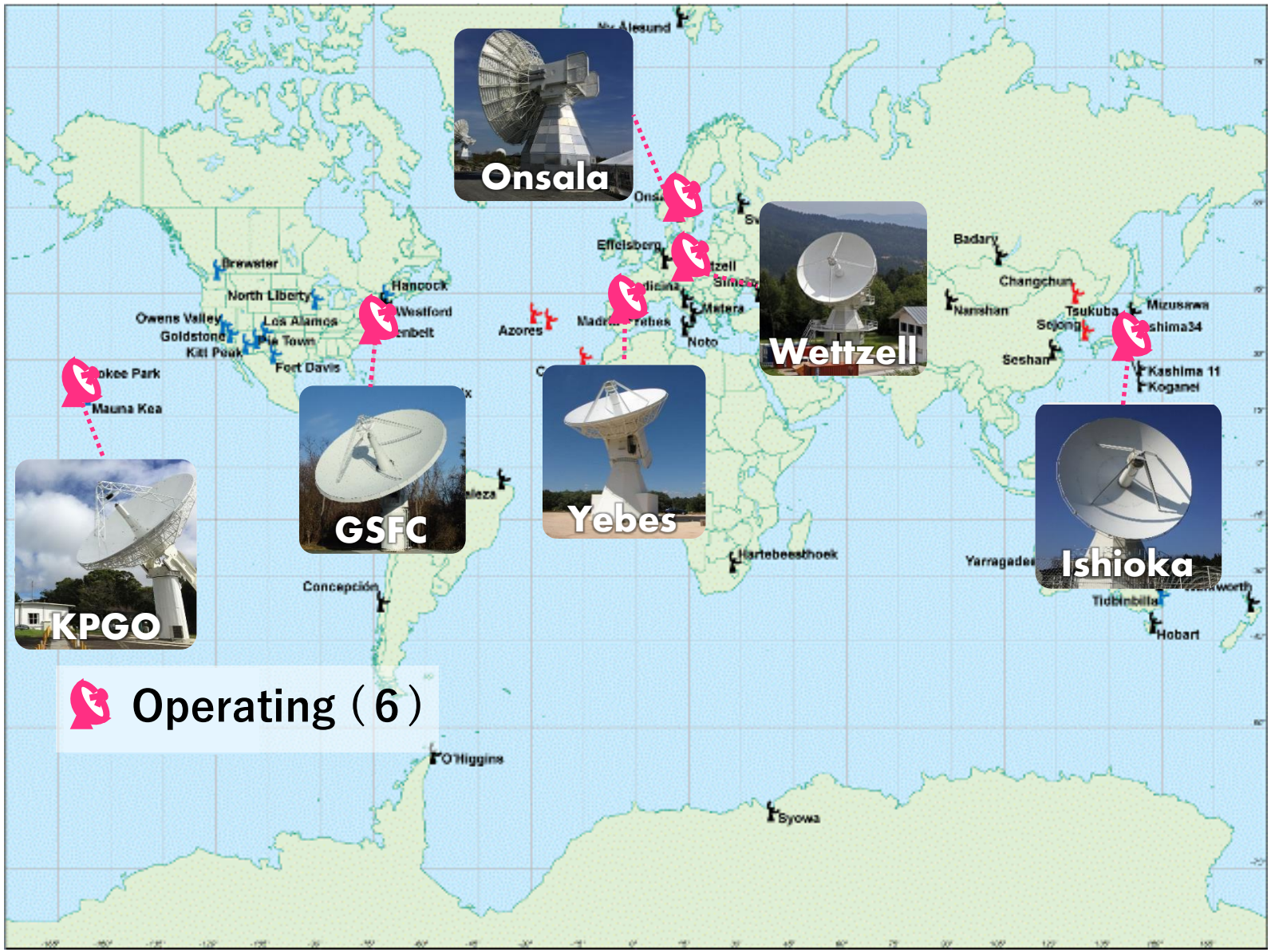
Mar. Retirement of Tsukuba

Nov.-Dec. **VGOS Test (CONT17)**

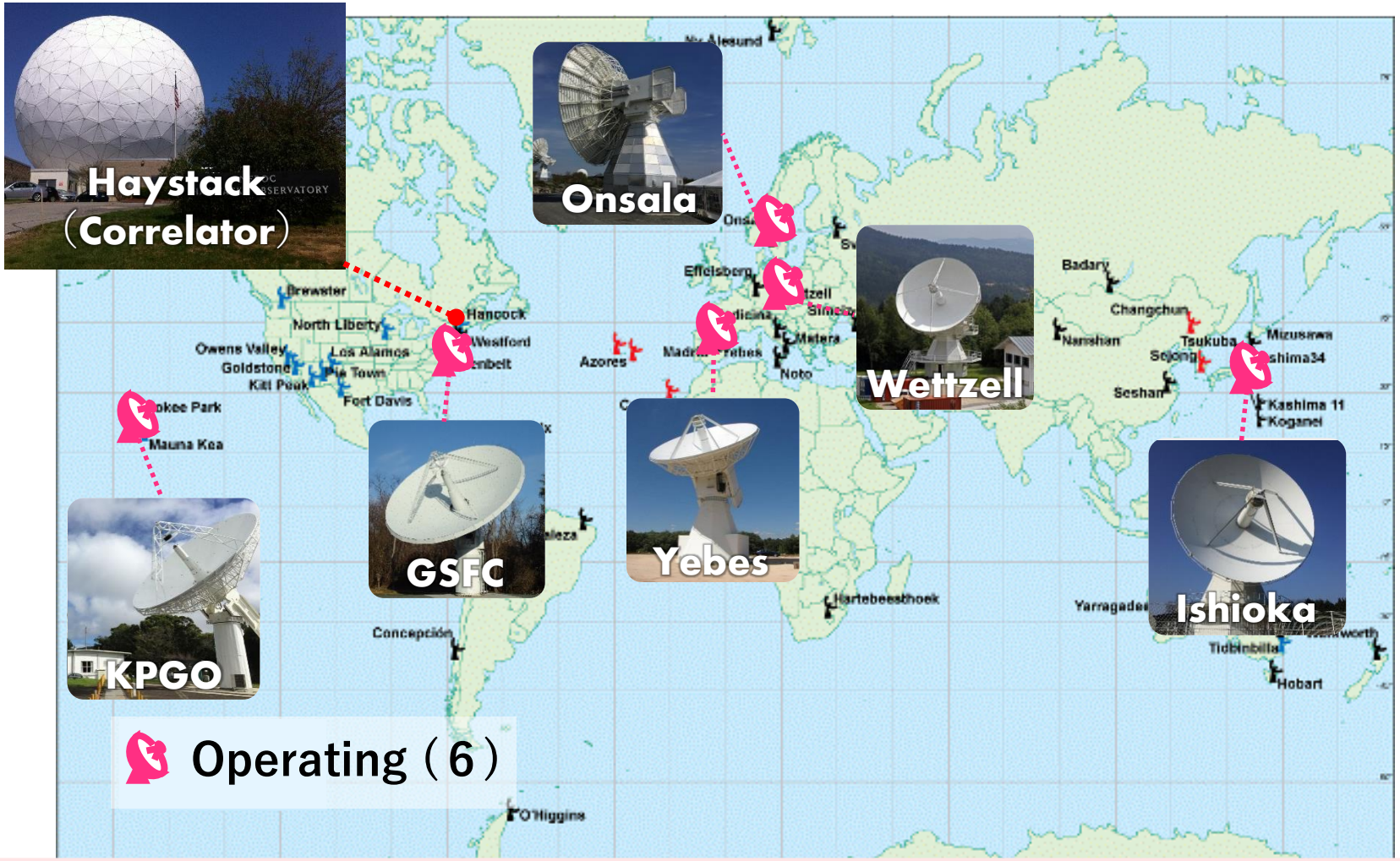
2018

Jun.-Sep. **VGOS Test (IVS, AOV, NICT)**

Current Status of VGOS Network



Current Status of VGOS Network

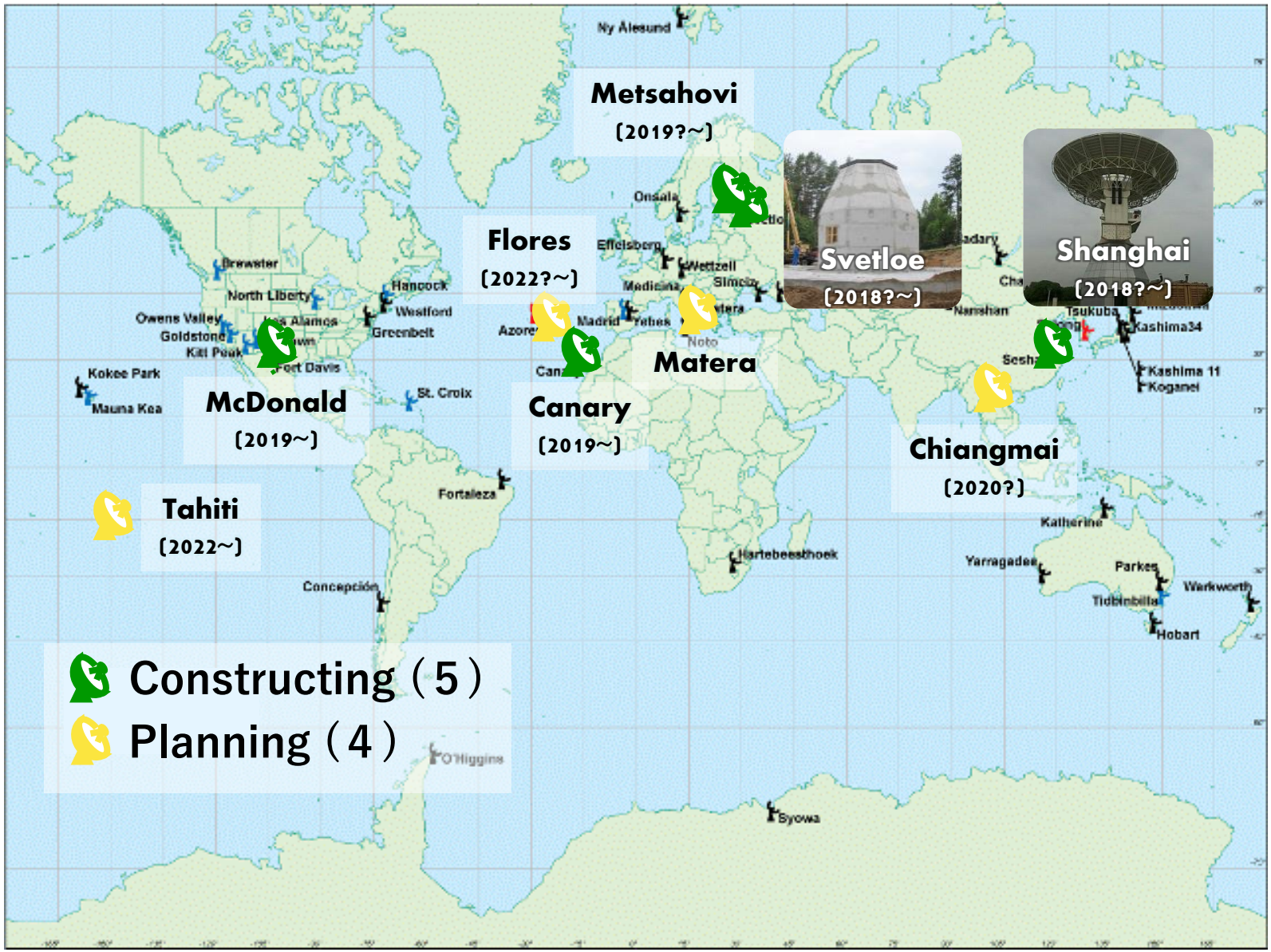


- Biweekly VGOS test observations (+ Westford) coordinated by IVS
- Correlated at MIT Haystack
- Improvement of operation, establishment of correlation processes

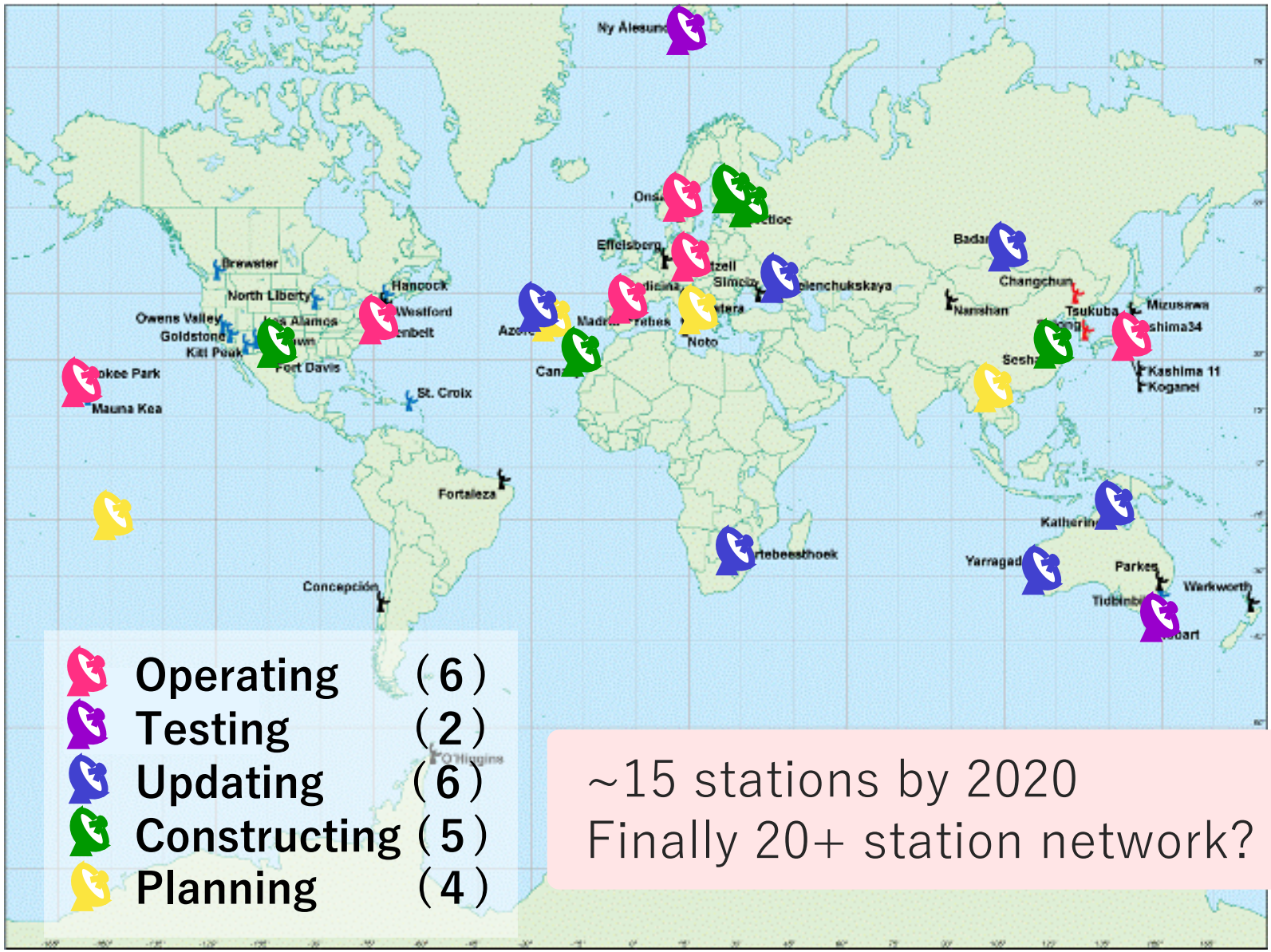
Current Status of VGOS Network

Latest VGOS Station

Current Status of VGOS Network



Current Status of VGOS Network



~15 stations by 2020
Finally 20+ station network?

Current Issues and Prospects

- Purpose of current VGOS test observations: Accumulating knowledge of full end-to-end operation
- Correlation is a bottleneck
  - ✓ Only Haystack can correlate VGOS data
  - ✓ Under establishment of correlation processes
  - ✓ (Sometimes) Unstable observing systems

Current Issues and Prospects

- Purpose of current VGOS test observations: Accumulating knowledge of full end-to-end operation
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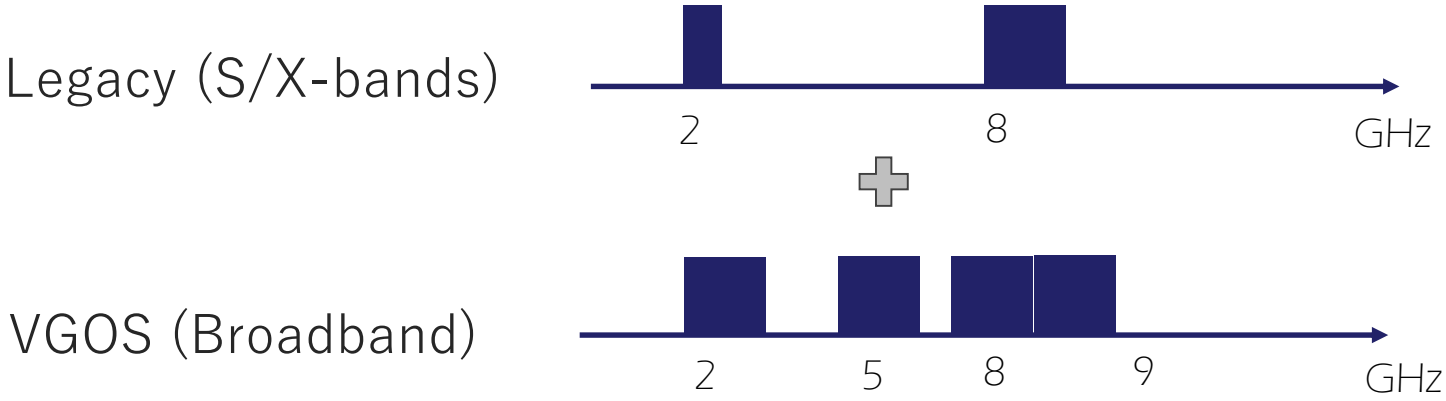
- Sharing the know-how of correlation
  - ✓ “Cookbook” will be published in this year
  - ✓ VGOS Correlation Workshop in May 2019 at Haystack
- “Mixed Mode” observation

“Mixed mode” Observation

- VGOS stations (broadband) participate in Legacy (S/X-bands) observation
- Continuity of products is secured when transition of observing system from Legacy to VGOS
  - ✓ VGOS stations are integrated in current products
  - ✓ Improvement of current products
- Different correlation processes are necessary among Legacy-Legacy, Legacy-VGOS, VGOS-VGOS baselines
  - ✓ First international test was conducted in July
  - ✓ Data are being correlated at Haystack
  - ✓ Next test is planned in December

(Niell et al (2018) IVS-GM)



Current Issues and Prospects

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- Continuous Observation
  - ✓ Observing plan for transition
  - ✓ “Dynamic Scheduling (at UTAS)”
- Low-latency products
  - ✓ Data transfer via high-speed network
  - ✓ Distributed Correlation, Cloud Correlation
  - ✓ Automation of correlation and analysis
- Expansion of Station Network
  - ✓ South America, Africa, Antarctica…

Summary

- IVS is promoting a new VLBI observing system "VGOS" to contribute to GGOS
- VGOS tests are performed biweekly with 7 stations
- VGOS network is expanding gradually

  → ~15 by 2020, 20+ finally?
- Correlation is a current bottleneck

  → Sharing knowledge, "Mixed mode" Observation
- Expansion of stations and correlators might advance VGOS development rapidly
- Next challenge is realization of continuous observation and low-latency products