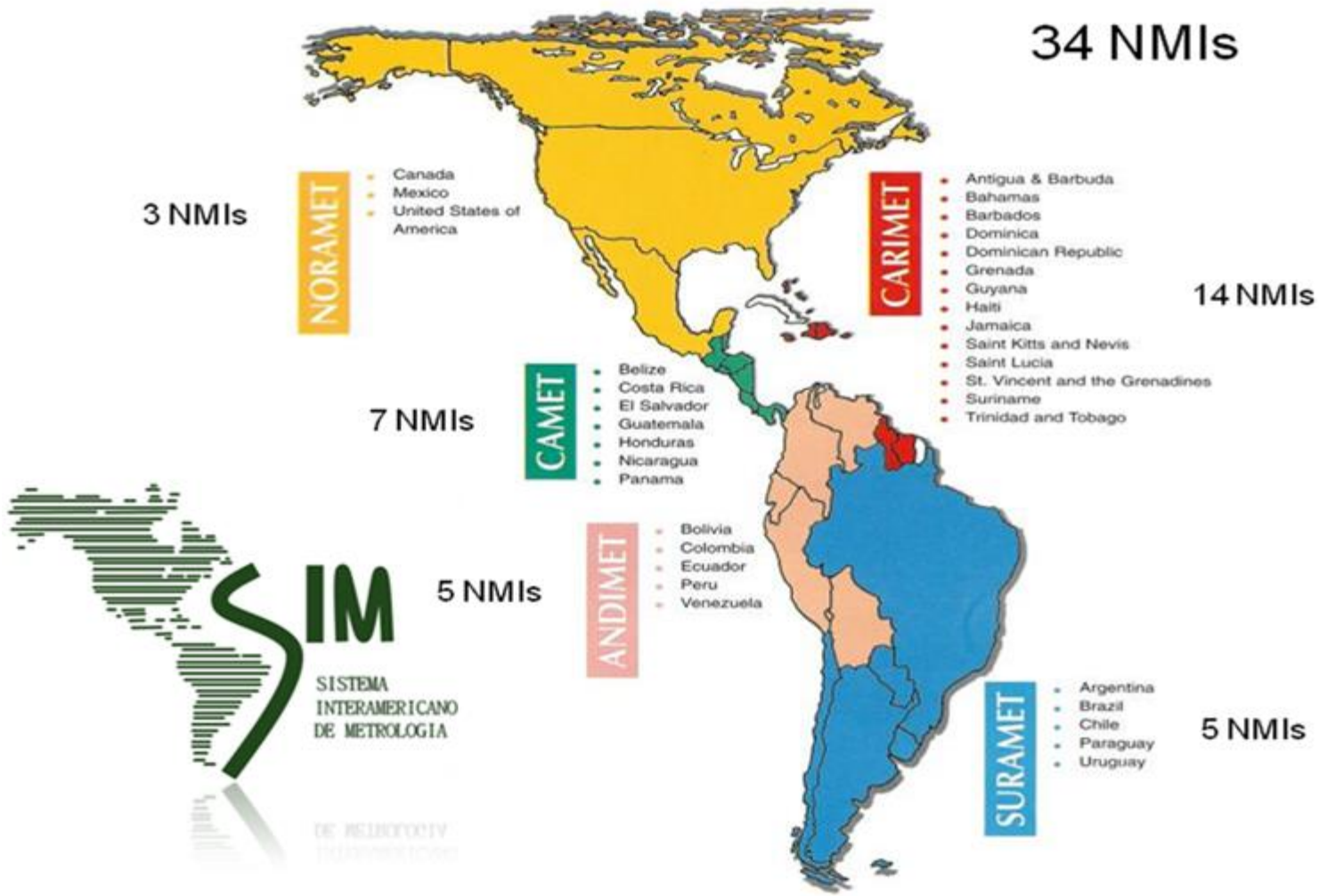
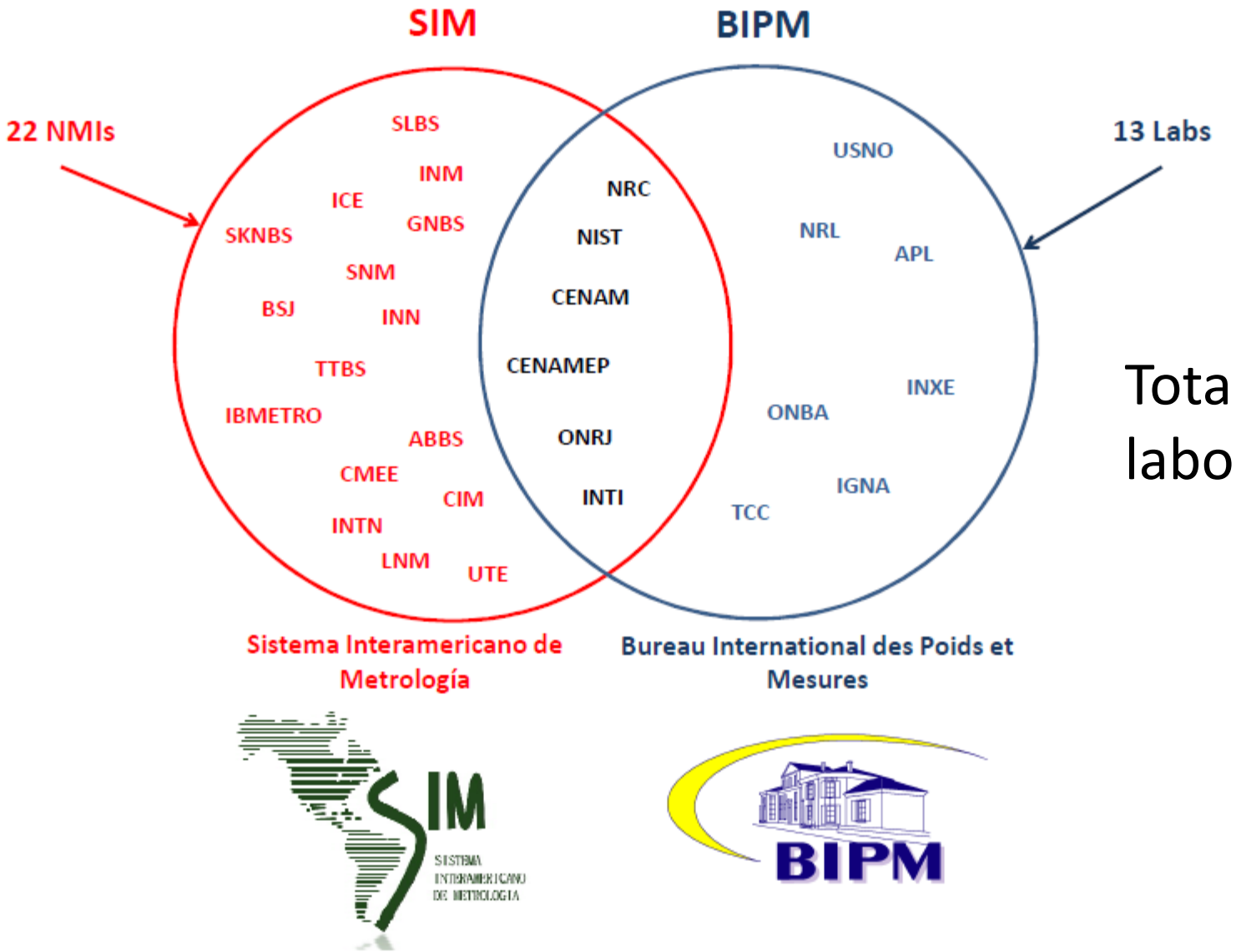
SIM Report to the 20th CCTF

Michael Lombardi, NIST, Chairman of the SIM WG on T&F
Mauricio Lopez, CENAM

SIM TIME AND FREQUENCY METROLOGY WORKING GROUP

Working to support time and frequency metrology throughout the Americas





Total number of laboratories: 30

Timing laboratories in SIM

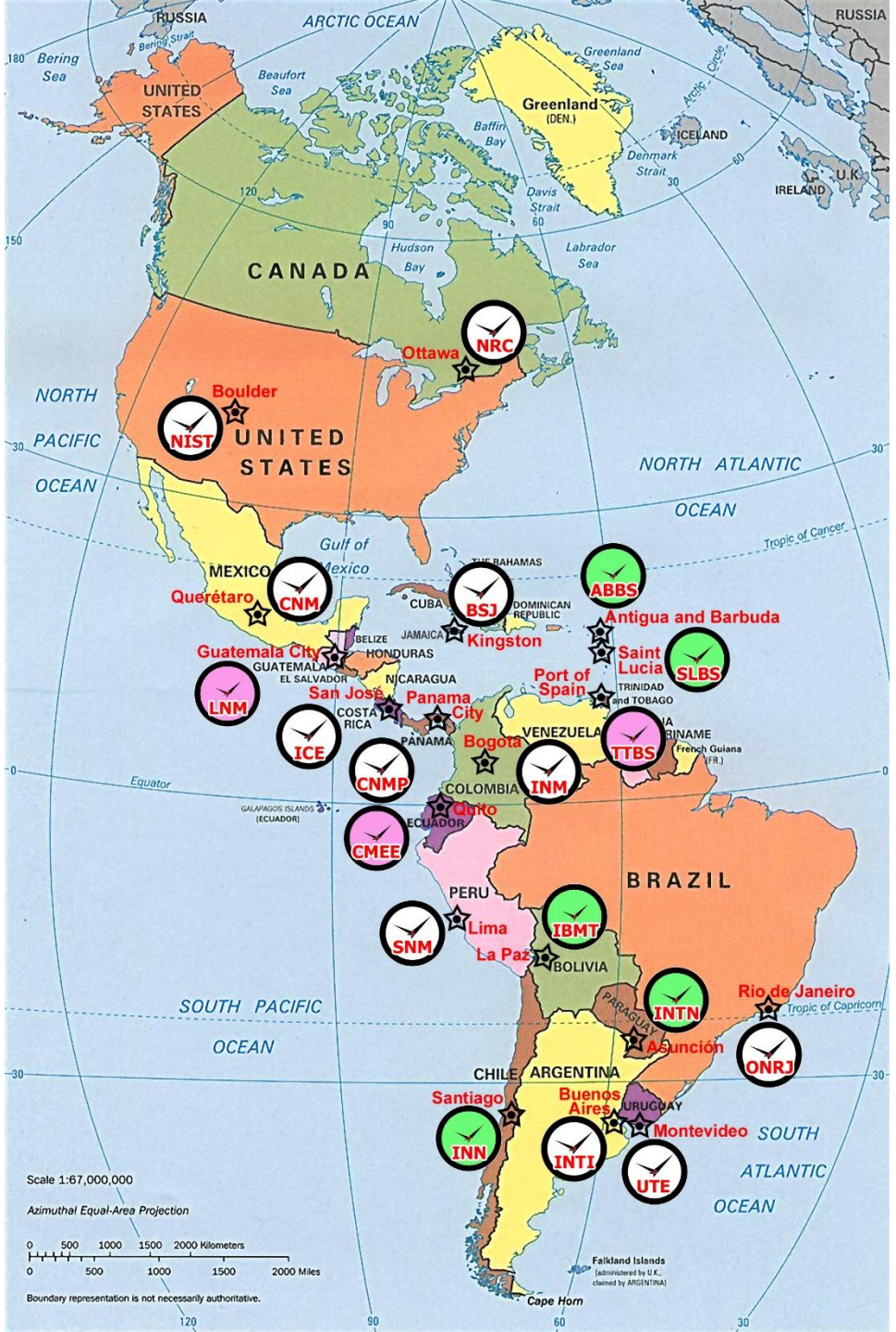


TABLE I

TIMEKEEPING LABORATORIES IN THE AMERICAS THAT PARTICIPATE IN INTERNATIONAL COMPARISONS

Laboratory	Country	NMI or DI	Time Scale	UTC contri-butor	Link to UTC	SIM Time Network	Radio Time Services	Internet Time Services
ABBS	Antigua & Barbuda)	NMI	SIMTDC	N	—	Y	N	N
INTI	Argentina	NMI	Cesium	Y	GPS	Y	N	N
ONBA	Argentina	DI	Cesium	Y	GPS	Y	N	N
IGNA	Argentina	—	Cesium	Y	GPS	Y	N	N
IBMETRO	Bolivia	NMI	SIMTDC	N	—	Y	N	Y
ONRJ	Brazil	DI	Ensemble	Y	GPS	Y	Y	Y
INXE	Brazil	NMI	Cesium	Y	GPS	N	N	N
NRC	Canada	NMI	Ensemble	Y	GPS	Y	Y	Y
TCC	Chile	—	SIMTDC	N	GPS	Y	N	N
INN	Chile	DI	SIMTDC	N	—	Y	N	N
INM	Colombia	NMI	Cesium	N*	GPS*	Y	N	Y
ICE	Costa Rica	DI	Cesium	N*	GPS*	Y	N	Y
CMEE	Ecuador	DI	GPSDC	N	—	Y	N	Y
CIM	El Salvador	NMI	SIMTDC	N	—	Y	N	N
LNM	Guatemala	NMI	GPSDC	N	—	Y	N	N
GNBS	Guyana	NMI	SIMTDC	N	—	Y	N	N
BSJ	Jamaica	NMI	Cesium	N	—	Y	N	N

TABLE 1

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ONBA	Argentina	DI	Cesium	Y	GPS	Y	N	N
IGNA	Argentina	—	Cesium	Y	GPS	Y	N	N
IBMETRO	Bolivia	NMI	SIMTDC	N	—	Y	N	Y
ONRJ	Brazil	DI	Ensemble	Y	GPS	Y	Y	Y
INXE	Brazil	NMI	Cesium	Y	GPS	N	N	N
NRC	Canada	NMI	Ensemble	Y	GPS	Y	Y	Y
TCC	Chile	—	SIMTDC	N	GPS	Y	N	N
INN	Chile	DI	SIMTDC	N	—	Y	N	N
INM	Colombia	NMI	Cesium	N*	GPS*	Y	N	Y
ICE	Costa Rica	DI	Cesium	N*	GPS*	Y	N	Y
CMEE	Ecuador	DI	GPSDC	N	—	Y	N	Y
CIM	El Salvador	NMI	SIMTDC	N	—	Y	N	N
LNM	Guatemala	NMI	GPSDC	N	—	Y	N	N
GNBS	Guyana	NMI	SIMTDC	N	—	Y	N	N
BSJ	Jamaica	NMI	Cesium	N	—	Y	N	N
CENAM	Mexico	NMI	Ensemble	Y	GPS	Y	Y	Y
CENAMEP	Panama	NMI	Cesium	Y	GPS	Y	N	Y
INTN	Paraguay	NMI	SIMTDC	N	—	Y	N	N
SNM	Peru	NMI	Cesium	N*	GPS*	Y	N	Y
SLBS	Saint Lucia	NMI	SIMTDC	N	—	Y	N	N
SKNBS	St. Kitts & Nevis	NMI	SIMTDC	N	—	Y	N	N
TTBS	Trinidad & Tobago	NMI	GPSDC	N	—	Y	N	N
NIST	United States	NMI	Ensemble	Y	TWSTFT	Y	Y	Y
USNO	United States	—	Ensemble	Y	TWSTFT	N	Y	Y
NRL	United States	—	Ensemble	Y	GPS	N	N	N
APL	United States	—	Ensemble	Y	GPS	N	N	N
UTE	Uruguay	DI	Cesium	N*	GPS*	Y	N	N

*Expected to become a UTC contributor in 2015

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The SIM Time Network

Volume 116 Number 2 March-April 2011

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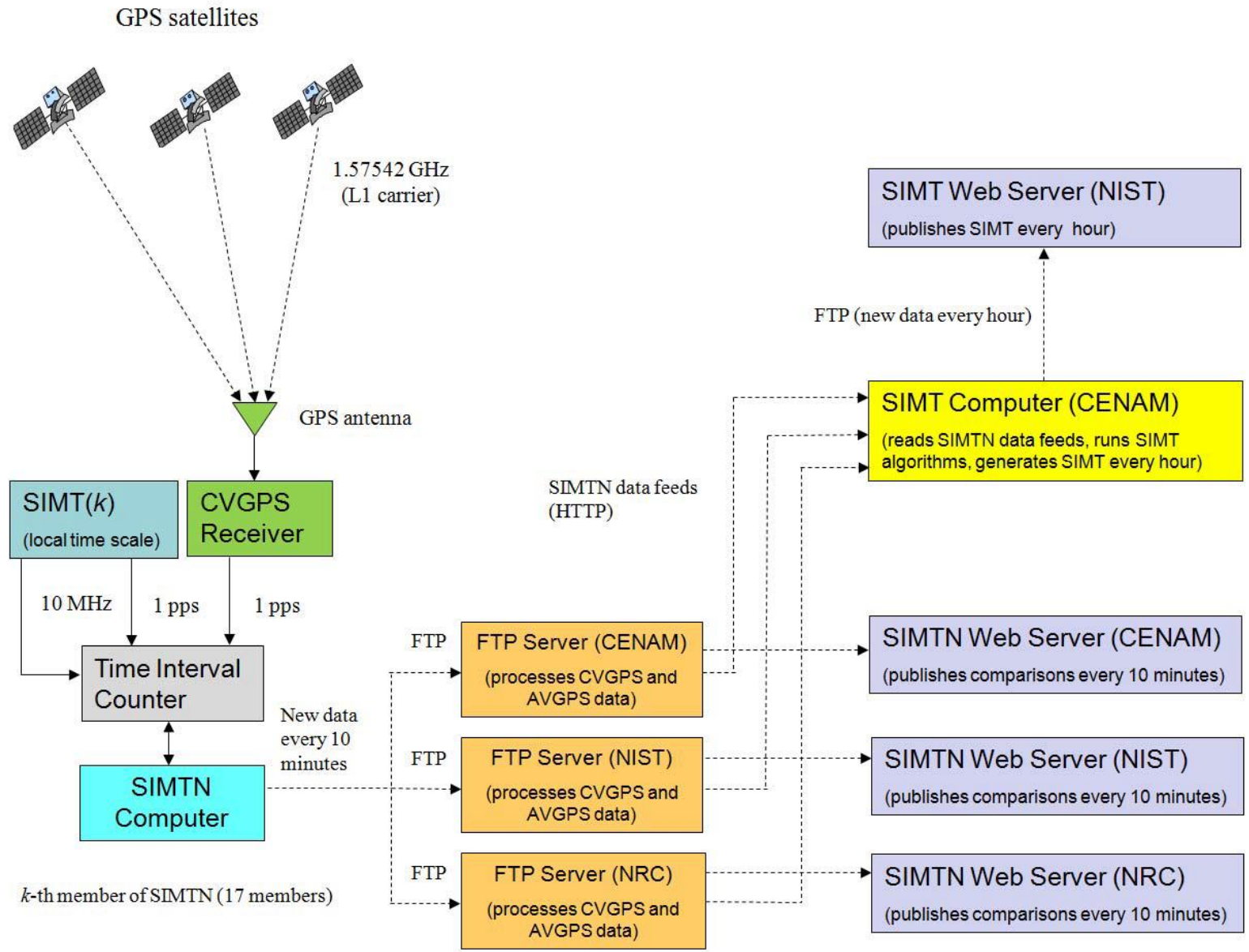
The *Sistema Interamericano de Metrologia* (SIM) is a regional metrology organization (RMO) whose members are the national metrology institutes (NMIs) located in the 34 nations of the Organization of American States (OAS). The SIM/OAS region extends throughout North, Central, and South America and the Caribbean Islands. About half of the SIM NMIs maintain national standards of time and frequency and must participate in international comparisons in order to establish metrological traceability to the International System (SI) of units. The SIM time network (SIMTN) was developed as a practical, cost effective, and technically sound way to automate these comparisons.

The SIMTN continuously compares the time standards of SIM NMIs and produces measurement results in near real-time by utilizing the Internet and the Global Positioning System (GPS). Fifteen SIM NMIs have joined the network as of December 2010. This paper provides a brief overview of SIM and a technical description of the SIMTN. It presents international comparison results and examines the measurement uncertainties. It also discusses the metrological


GPS satellites
1.57542 GHz
(L1 carrier)
GPS antenna
SIMT(k)
(local time scale)
CVGPS
Receiver
10 MHz
1 pps
1 pps
Time Interval
Counter
SIMTN
Computer
New data
every 10
minutes
k-th member of SIMTN (17 members)
SIMTN data feeds
(HTTP)
FTP
FTP Server (CENAM)
(processes CVGPS and
AVGPS data)
FTP
FTP Server (NIST)
(processes CVGPS and
AVGPS data)
FTP
FTP Server (NRC)
(processes CVGPS and
AVGPS data)
SIMT Web Server (NIST)
(publishes SIMT every hour)
FTP (new data every hour)
SIMT Computer (CENAM)
(reads SIMTN data feeds, runs SIMT
algorithms, generates SIMT every hour)
SIMTN Web Server (CENAM)
(publishes comparisons every 10 minutes)
SIMTN Web Server (NIST)
(publishes comparisons every 10 minutes)
SIMTN Web Server (NRC)
(publishes comparisons every 10 minutes)

http://132.163.4.82/scripts/sim_rx_grid.exe — BIPM - BIPM — SIM Time Network Compari...

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Correo Cinvestav Proyecto CENAPROT

www.tf.nist.gov/sim

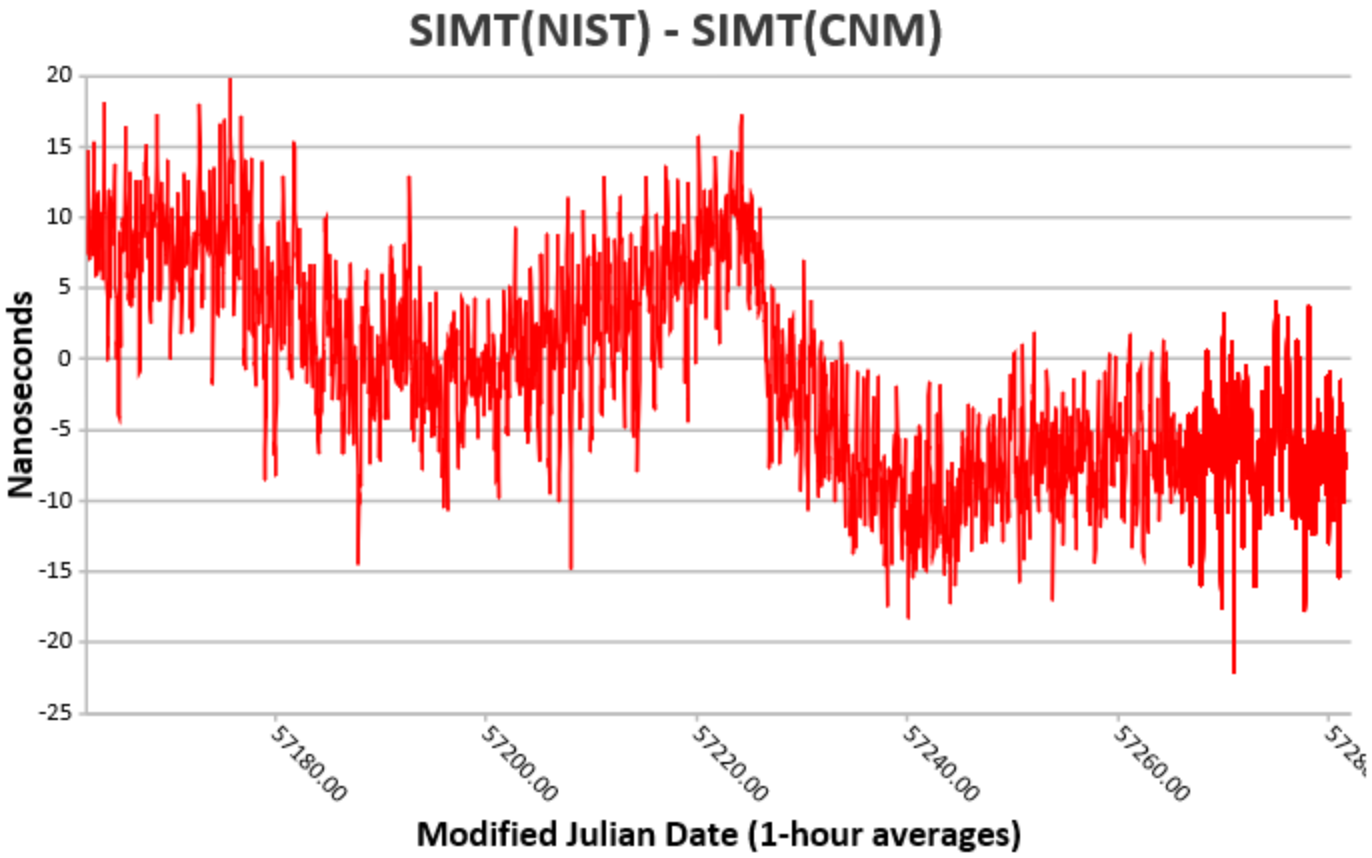
SIM Time Network

(real-time measurement results for the 10-minute period ending on 09-16-2015 at 1020 UTC)

	United States SIMT(NIST)	Mexico SIMT(CNM)	Canada SIMT(NRC)	Panama SIMT(CNMP)	Brazil SIMT(ONRJ)	Costa Rica SIMT(ICE)	Colombia SIMT(INM)	Argentina SIMT(INTI)	Guatemala SIMT(CNME)	Jamaica SIMT(BSJ)	Uruguay SIMT(UTE)	Paraguay SIMT(INTN)	Peru SIMT(INACAL)	Trinidad SIMT(TTBS)	St. Lucia SIMT(SLBS)	Chile SIMT(INN)	Antigua SIMT(ABBS)	Ecuador SIMT(CMEE)	Bolivia SIMT(IBMET)	St. Kitts SIMT(SKBS)	Guyana SIMT(GNBS)	El Salvador SIMT(CIM)
United States SIMT(NIST)		8.5	35.6	-8.6	14.6	-5.3		-1.8	22.8			-8.7	-112.6	-254.7	15.3	10.1	1382.9	-54.6	20.4	66.5			
Mexico SIMT(CNM)	-8.5		29.2	-23.8	-7.3	-15.1		-23.6	13.4			-28.1	-130.7	-269.9	-4.7	-6.2	1375.1	-72.9	1.7	57.2			
Canada SIMT(NRC)	-35.6	-29.2		-43.9	-22.2	-40.5		-38.7	-12.3			-46.2	-147.3	-290.4	-20.0	-27.4	1347.6	-91.5	-16.2	30.8			
Panama SIMT(CNMP)	8.6	23.8	43.9		21.2	3.4		9.0	31.6			1.7	-103.3	-247.1	17.7	24.4	1389.0	-48.2	28.0	68.2			
Brazil SIMT(ONRJ)	-14.6	7.3	22.2	-21.2		-18.4		-12.7	8.2			-17.6	-121.9	-269.8	-10.1	5.0	1359.7	-66.6	9.1	33.2			
Costa Rica SIMT(ICE)	5.3	15.1	40.5	-3.4	18.4			2.0	28.1			-5.7	-108.8	-247.7	23.6	13.1	1389.6	-49.3	24.5	75.5			
Colombia SIMT(INM)																							
Argentina SIMT(INTI)	1.8	23.6	38.7	-9.0	12.7	-2.0			24.6			-6.1	-112.1	-255.8	3.3	17.2	1373.6	-54.6	20.3	47.2			
Guatemala SIMT(CNME)	-22.8	-13.4	12.3	-31.6	-8.2	-28.1		-24.6				-32.3	-135.1	-276.2	-4.7	-13.5	1361.4	-77.4	-2.1	46.7			
Jamaica SIMT(BSJ)																							
Uruguay SIMT(UTE)																							
Paraguay SIMT(INTN)	8.7	28.1	46.2	-1.7	17.6	5.7		6.1	32.3				-104.5	-251.5	13.2	22.9	1384.2	-47.4	27.0	52.8			
Peru SIMT(INACAL)	112.6	130.7	147.3	103.3	121.9	108.8		112.1	135.1			104.5		-143.9	123.9	128.1	1492.8	56.6	131.5	172.5			
Trinidad SIMT(TTBS)	254.7	269.9	290.4	247.1	269.8	247.7		255.8	276.2			251.5	143.9		261.8	272.0	1633.4	199.1	275.9	311.4			
St. Lucia SIMT(SLBS)	-15.3	4.7	20.0	-17.7	10.1	-23.6		-3.3	4.7			-13.2	-123.9	-261.8		6.2	1368.6	-66.6	7.0	47.3			

05:26 a. m.
16/09/2015

Hours in Common-View	Mean Time Offset (ns)	Range (ns)	Frequency Offset	Confidence (r)
2865	-0.98	42.05	-1.62×10^{-15}	-0.68



Allan Deviation

Averaging Time (τ) (hours, minutes)	Samples	Frequency Stability

(SIMT - SIMT(*k*) for the 1-hour period ending on 2015-09-16 at 10:20:00 UTC)

National Standard	National Flag	SIMT - SIMT(*k*), ns	SIMT Contribution	National Standard	National Flag	SIMT - SIMT(*k*), ns	SIMT Contribution
United States SIMT(NIST)		16.47	39.23 %	Guatemala SIMT(LNM)		0.77	0.00 %
Canada SIMT(NRC)		-22.95	21.75 %	Paraguay SIMT(INTN)		-2.63	0.00 %
Mexico SIMT(CNM)		-0.35	20.29 %	Trinidad SIMT(TTBS)		281.37	0.00 %
Brazil SIMT(ONRJ)		4.81	9.09 %	St. Lucia SIMT(SLBS)		-123.43	0.00 %
Costa Rica SIMT(ICE)		2.47	4.42 %	Chile SIMT(INN)		17.07	0.00 %
Panama SIMT(CNMP)		-3.49	2.92 %	Antigua SIMT(ABBS)		-894.23	0.00 %
Argentina SIMT(INTI)		17.35	1.89 %	Ecuador SIMT(CMEE)		81.87	0.00 %
Peru SIMT(INACAL)		124.63	0.41 %	Bolivia SIMT(IBMET)		52.67	0.00 %
Colombia SIMT(INM)		---	0.00 %	St. Kitts SIMT(SKNBS)		1.57	0.00 %
Jamaica SIMT(BSJ)		---	0.00 %	El Salvador SIMT(CIM)		---	0.00 %
Uruguay SIMT(UTE)		---	0.00 %	Dominican Rep. SIMT(INDOCAL)		---	0.00 %
Guyana SIMT(GNBS)		---	0.00 %	Belize SIMT(BBS)		---	0.00 %

Click on a SIMT - SIMT(*k*) value to view today's graph. New values are computed at 30 minutes after the hour. This table was updated at 10:31:46 UTC and refreshes every 30 minutes.

SIM Time Scale

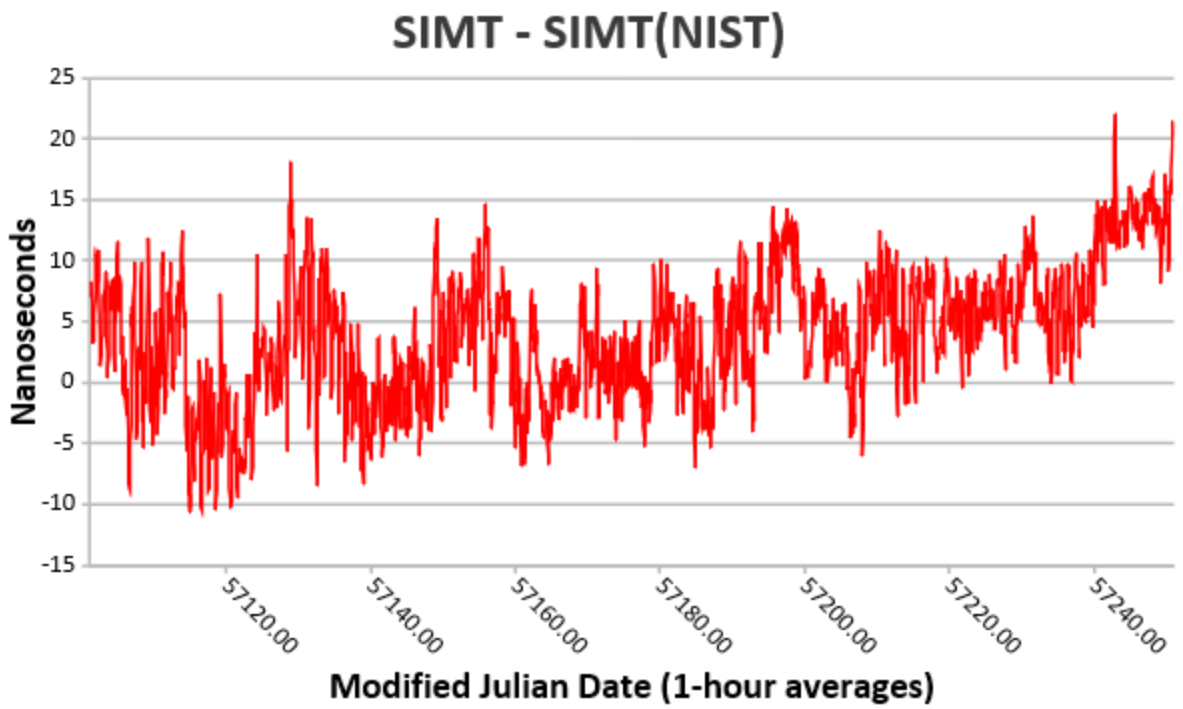
José Mauricio López-Romero, Michael A. Lombardi, *Member, IEEE*, Nélida Diaz-Muñoz, and Eduardo de Carlos-Lopez

Country	Year of First Participation	Time Standard
United States	2005	Ensemble time scale
Mexico	2005	Ensemble time scale
Canada	2005	Ensemble time scale
Panama	2005	Cesium
Brazil	2006	Ensemble time scale
Costa Rica	2007	Cesium
Colombia	2007	Cesium
Argentina	2007	Cesium
Guatemala	2007	GPSDO
Jamaica	2007	Cesium
Uruguay	2008	Cesium
Paraguay	2008	Rubidium
Peru	2009	Cesium
Trinidad & Tobago	2009	GPSDO
Saint Lucia	2010	Rubidium
Chile	2010	Rubidium
Antigua and Barbuda	2011	Rubidium
Ecuador	2012	GPSDO
Bolivia	2012	Rubidium

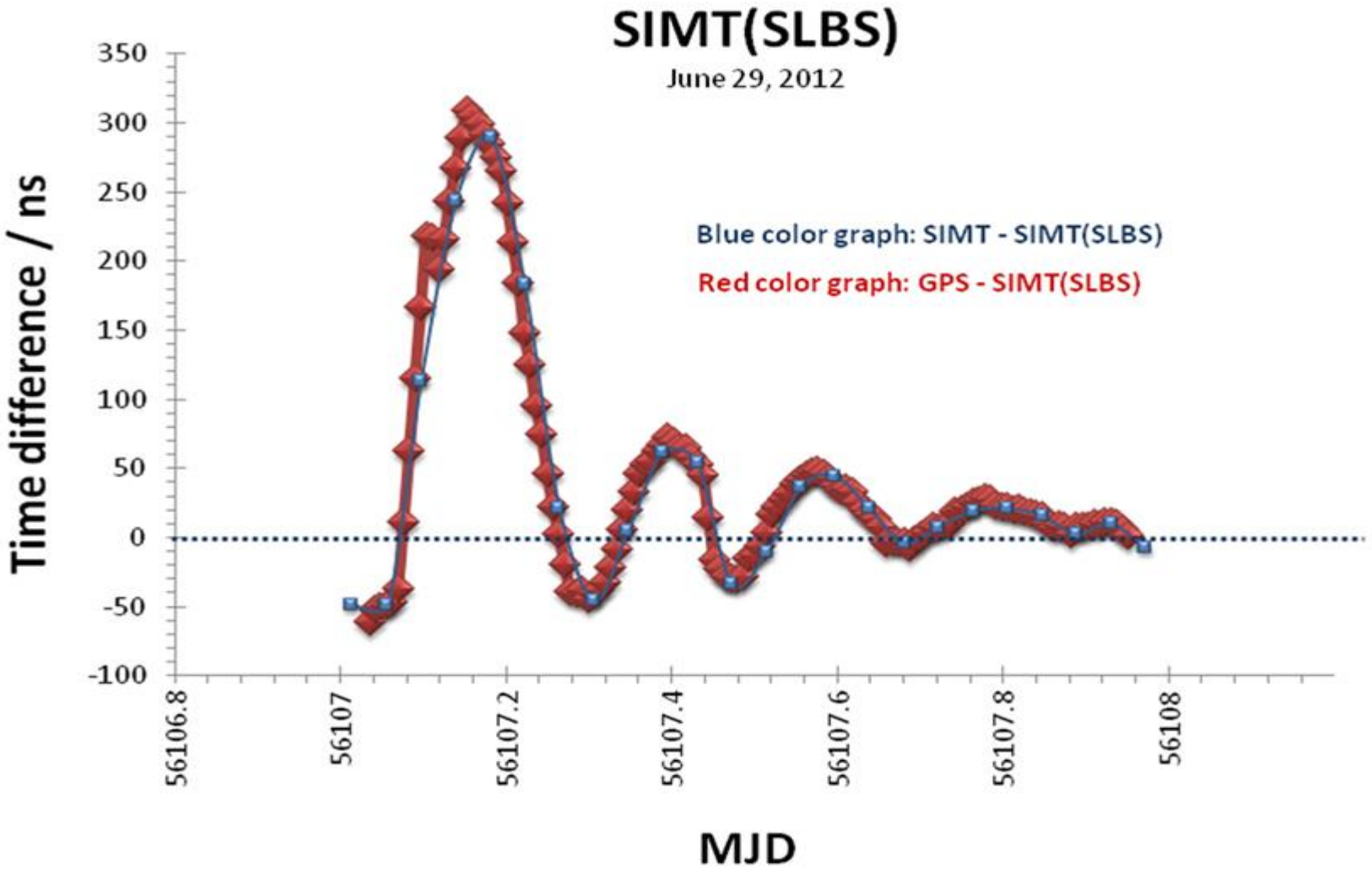
SIMT - SIMT(NIST) for the 150 day period ending 2015-08-16

Return to Grid | Next Time Scale | Previous Time Scale | Next Date | Last Date

Hours	Mean Time Offset (ns)	Range (ns)	Frequency Offset	Confidence (r)
3594	3.97	32.75	$<1.0 \times 10^{-15}$	+0.52



Remote realization of SIMT time scale



Strong cooperation and coordination program

- Strong training program in time and frequency.
- Development of customized equipment to provide small countries with minimal equipment to have national time and frequency references with traceability to the SI second.
- In some cases it is provided GNSS equipment to the NMIs to contribute with measurement data to the BIPM for UTC computation.
- Most of the SIM NMIs are currently traceable to the SI second through the SIM Time Network.