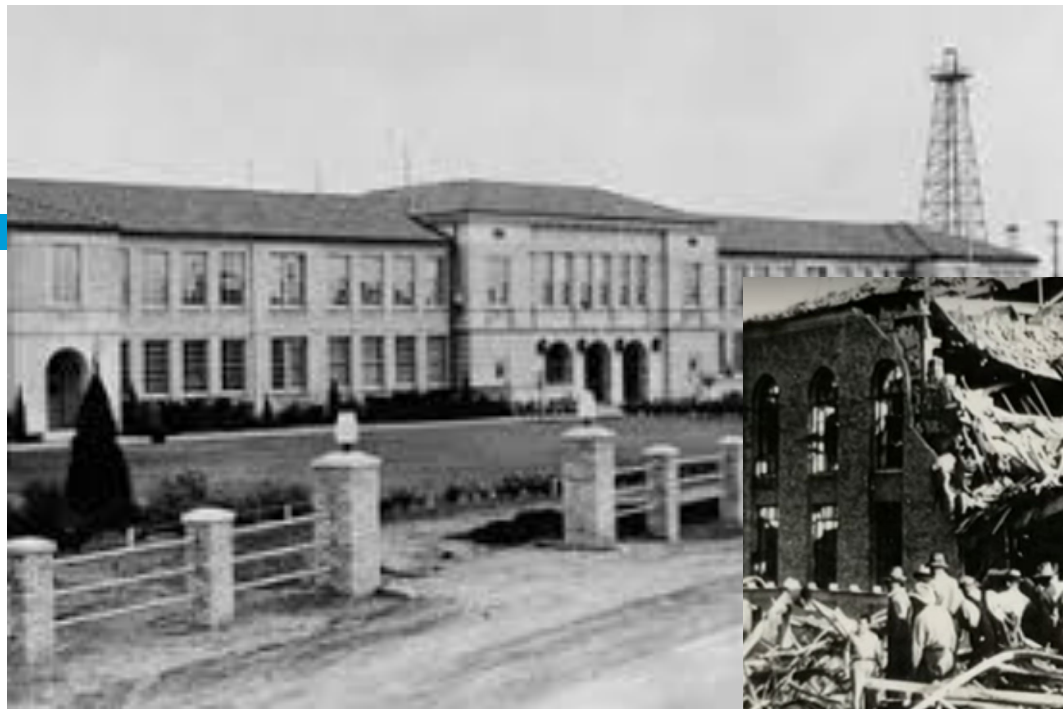




# A Resilient National Timing Architecture

APRIL 2021

WSTS 2021



Nationalboard.org



Nationalboard.org





By Wally Gobetz, CC BY 2.0,  
<https://commons.wikimedia.org/w/index.php?curid=7972261>







By Wally Gobetz, CC BY 2.0,  
<https://commons.wikimedia.org/w/index.php?curid=7972261>

USCG Petty Officer 2nd  
Class Kyle Niemi



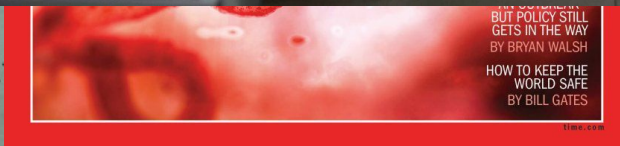


By Wally Gobetz, CC BY 2.0,  
<https://commons.wikimedia.org/w/index.php?curid=7972261>

USCG Petty Officer 2nd  
Class Kyle Niemi







Shutterstock

By Wally Gobetz, CC BY 2.0,  
<https://commons.wikimedia.org/w/index.php?curid=7972261>

USCG Petty Officer 2nd  
Class Kyle Niemi



MAY 15, 2017



WORLD SAFE  
BY BILL GATES

Shutterstock



By Wally Gobetz, CC BY 2.0,  
<https://commons.wikimedia.org/w/index.php?curid=7972261>

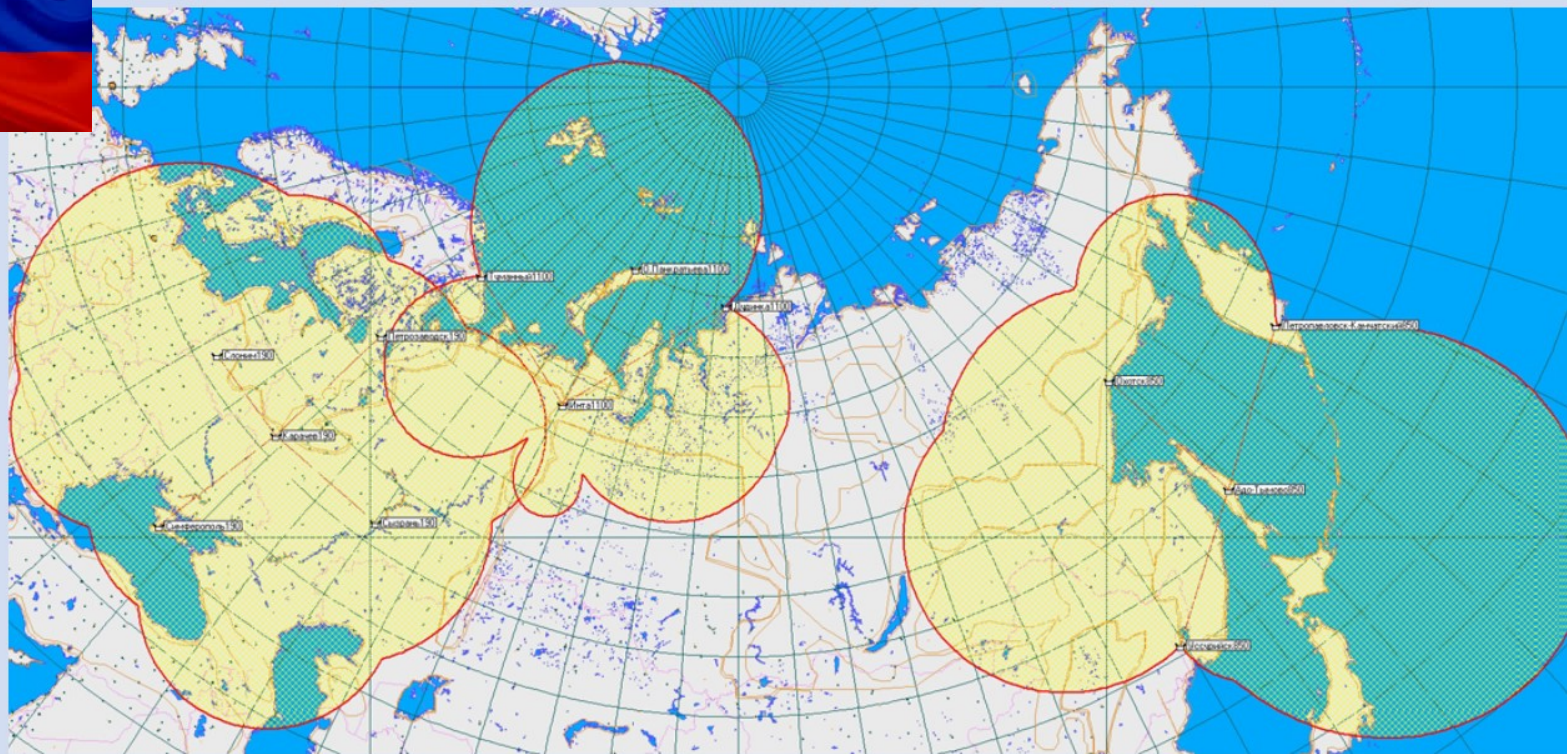
USCG Petty Officer 2nd  
Class Kyle Niemi







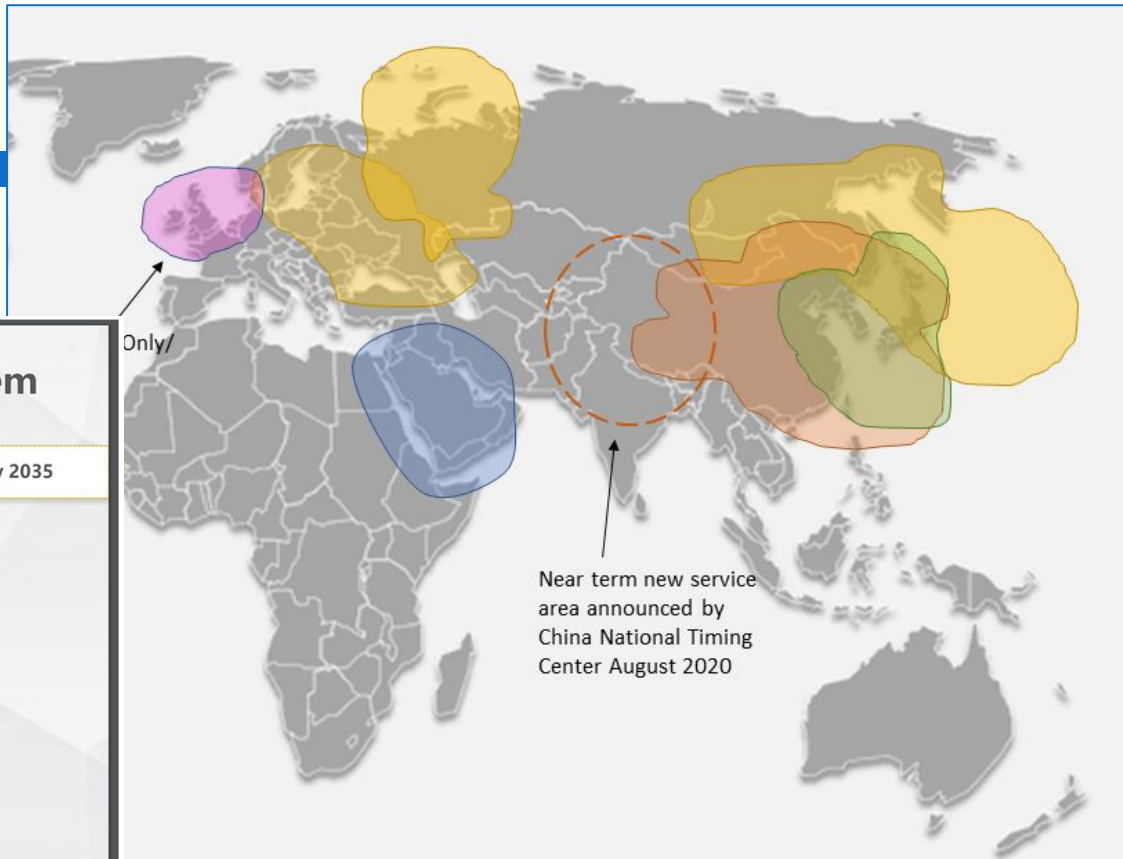
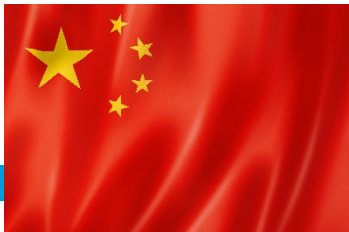




## Russia's Chayka (Loran) Coverage

Internavigation Research & Technical Centre of Advanced Navigation  
Technologies, August 2017

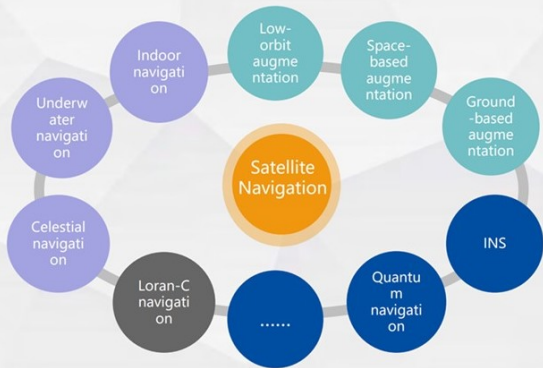




## 2. System Construction of PNT System

### (2) Prospect of the Development

It's expected to be built into a national comprehensive PNT system by 2035  
**more ubiquitous, more integrated, more intelligent,**



Service Areas Approximate. Consult national authorities in UK, Saudi Arabia, Russian Federation, China, & South Korea for more information



# Iran·Developing·Homegrown·Alternative·to·GPS¶

News·ID:·1090226·Service:·Defense¶

□·June,·01,·2016·--·13:55¶

TEHRAN·(Tasnim)·—·Iran's·defense·minister on·Wednesday·unveiled·three·of·the·latest technological·achievements·made·by·local experts,·including·the·transmitter·of·an indigenous·positioning·and·navigation system·that·could·be·a·substitute·for·the Global·Positioning·System·(GPS).¶

Speaking·at·the·ceremony,·Dehqan·said·it·was inevitable·that·the·country·find·a·replacement for·the·GPS,·which·is·currently·employed·for



In·a·ceremony·at·Malek·Ashtar·University·of·Technology·in·Tehran,·Brigadier·General·Hossein·Dehqan·unveiled·three·new·products·developed·by·the·university's·researchers.¶



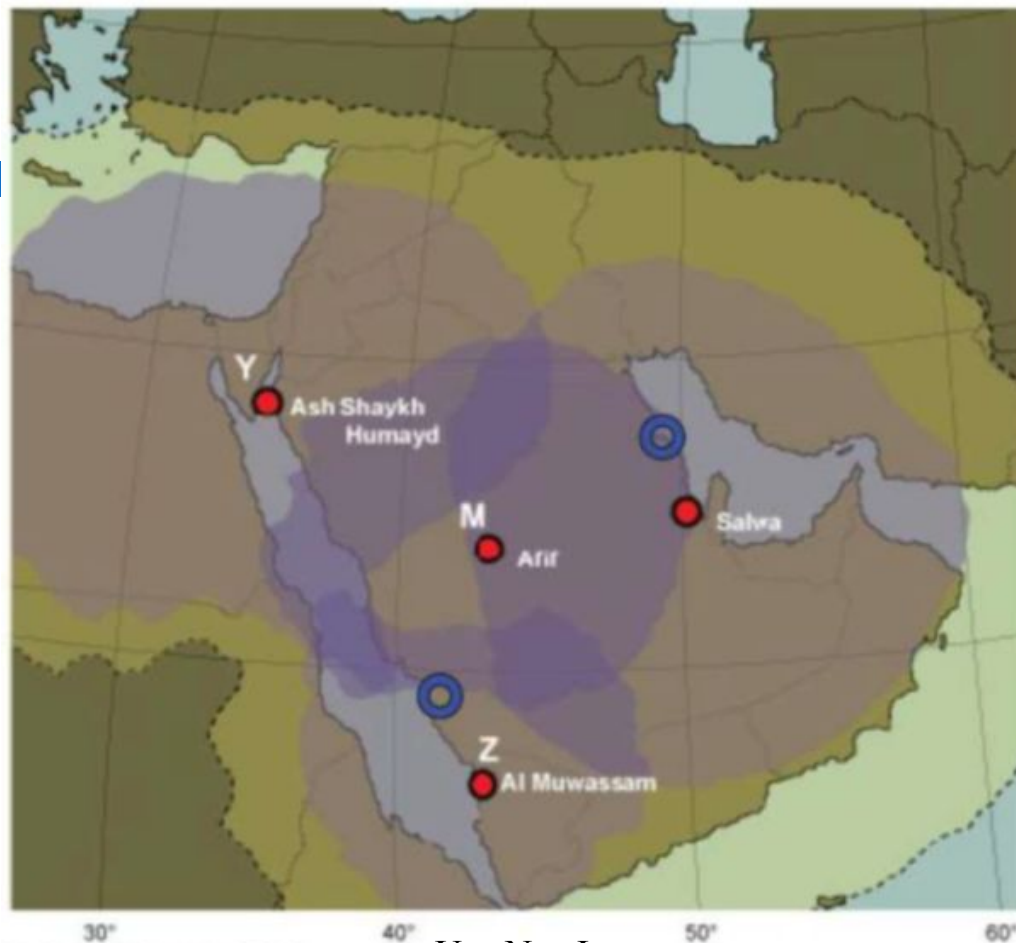




الإسلام  
الدين  
الوحيد



Saudi Arabia  
Loran-C



UrsaNav Image



1998 – We may have a problem

2001 – We definitely have a problem

2004 – Get a backup (Pres. G. W. Bush to DoT)

2008 – We will convert Loran-C to eLoran (DHS)

2010 – Loran-C shutdown, \$36M/yr “saved,” no backup

2015 – We will backup GPS with eLoran time, then PNT (DoD & DOT)

2020 – ‘GPS is not sufficient PNT, protect yourselves’ (Pres Trump)





2014 – Stop demolishing Loran until backup decision

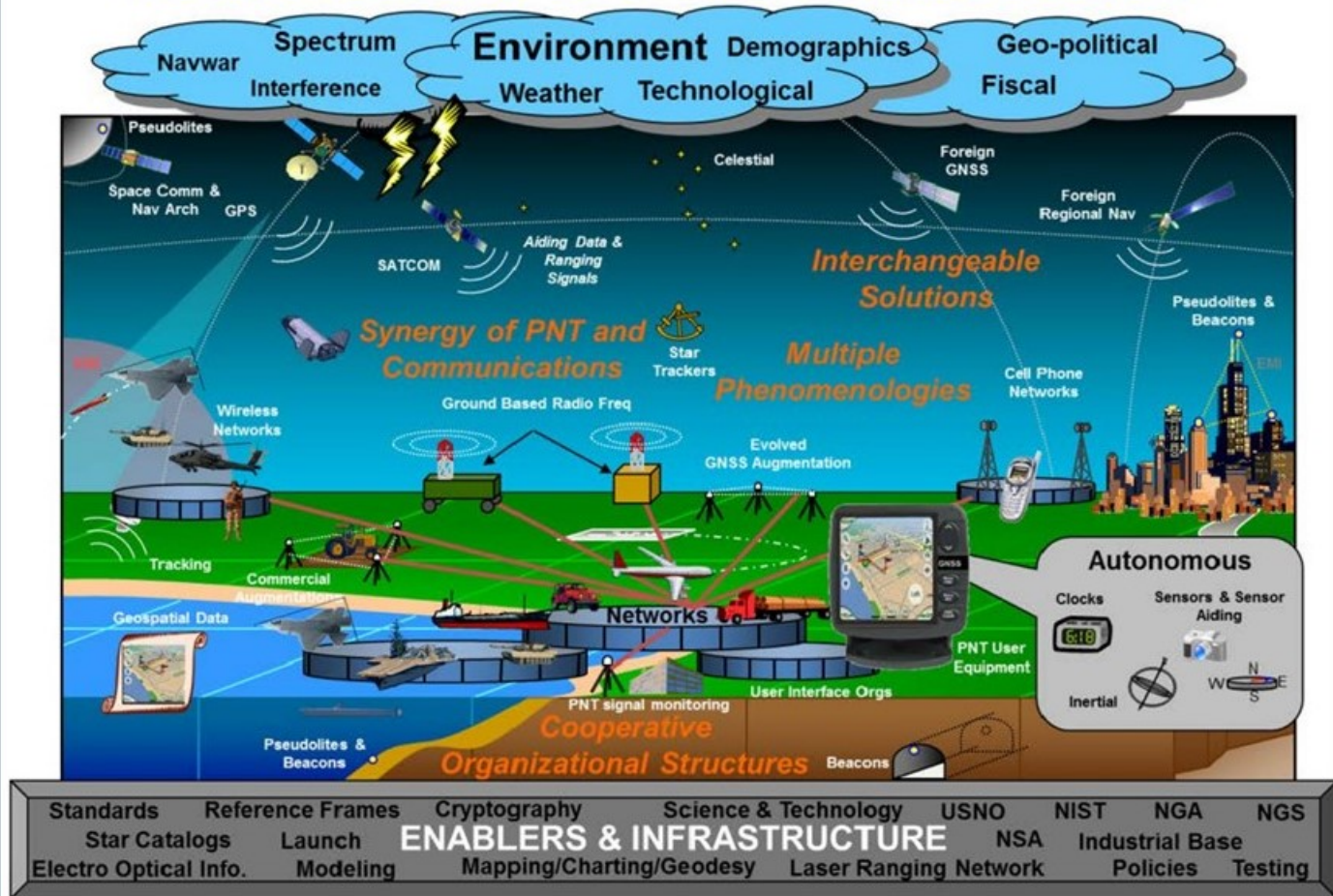
2017 – Do a tech demo, \$10M provided in 2018

2018 – National Timing Resilience and Security Act

- At a minimum - wide area, terrestrial
- Incorporate results of any tech demo
- Working through commercial services allowed
- Estab capability by December 2020



# National PNT Architecture



N

GLOBAL

CONTINENTAL

LOCAL



Standards

Star Catalog

Electro Optical Imaging

Modeling

Mapping

Sharing

Security

Laser Ranging Network

Policies

Testing

© 2015, Resilient Navigation and Timing Foundation | RNTFnd.org





N

GLOBAL

CONTINENTAL

LOCAL

Na

Pseudol

Space Com  
Nav Arc

Track

Geospatial

Standards  
Star Cata  
Electro Optical

Regional Satell

eLo

# Layered PNT Architecture Construct

<b>Global</b>	Space-based, Ubiquitous, 3-Dimensional Position and Precise Time
<b>Regional</b>	Space-based or Terrestrial, Non-global (National/International) Coverage
<b>Local</b>	Space-based, Terrestrial, and/or Autonomous, Localized by design/performance

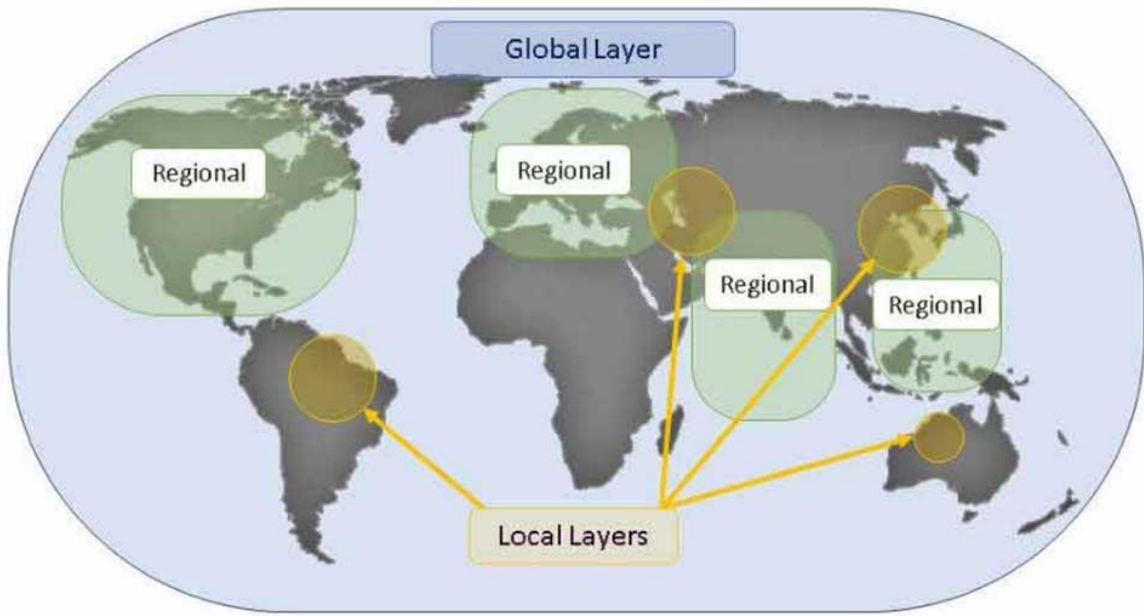
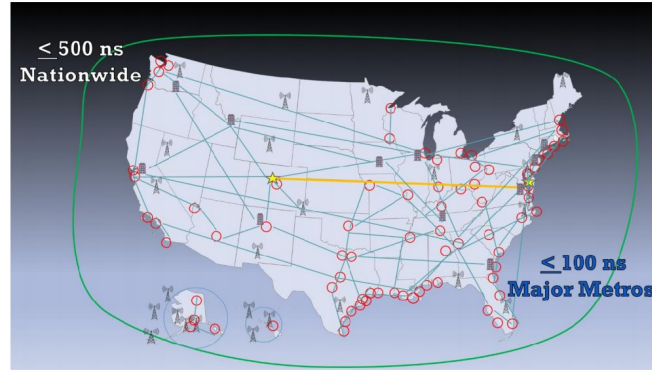


Figure 7 – Layered PNT Enterprise Architecture





## A Resilient National Timing Architecture

SECURING TODAY'S SYSTEMS, ENABLING TOMORROW'S

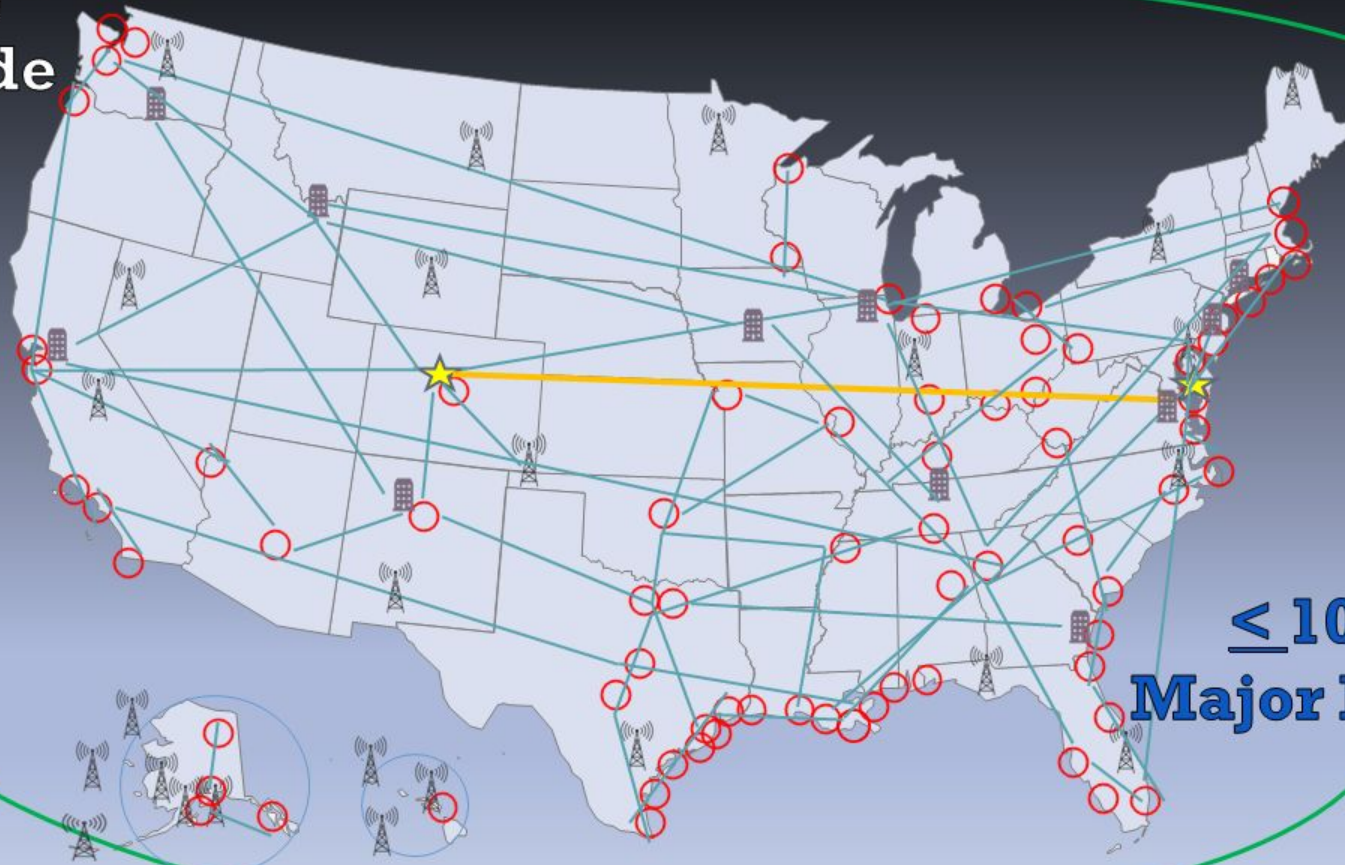
DR MARC WEISS, DR PATRICK DIAMOND, MR DANA A. GOWARD

© RNT Foundation - Reproduction and distribution authorized provided RNT Foundation is credited.

<https://rntfnd.org/library/>



< 500 ns  
Nationwide



≤ 100 ns  
Major Metros





# Complementary PNT and GPS Backup Technologies Demonstration Report

## Sections I through IO

Andrew Hansen, Ph.D.  
Stephen Mackey  
Hadi Wassaf, Ph.D.  
Vaibhav Shah  
Eric Wallischek  
Christopher Scarpone  
Michael Barzach  
Elliott Baskerville

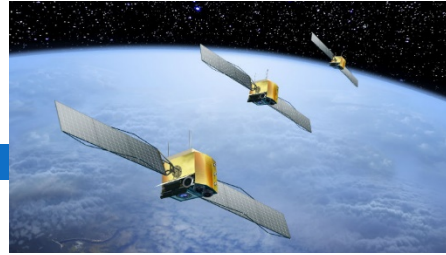
January 2021  
DOT-VNTSC-20-07

Prepared for:  
Office of the Assistant Secretary for Research and Technology,  
Department of Transportation



50  
YEARS  
1970 - 2020

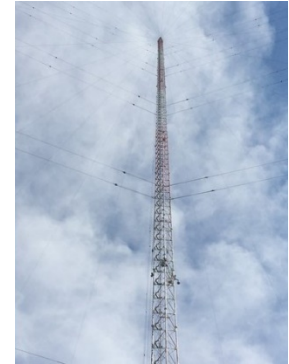
U.S. Department of Transportation  
**Volpe Center**



L Band fm  
Space



UHF



LF



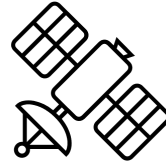
Fiber





*... in Order to form a more perfect  
Union, establish Justice, insure domestic  
Tranquility, provide for the common  
defense, promote the general Welfare...*

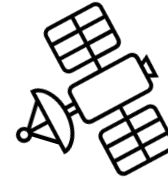
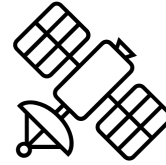
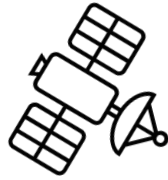
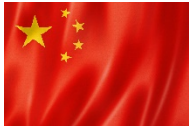




PNT a free utility

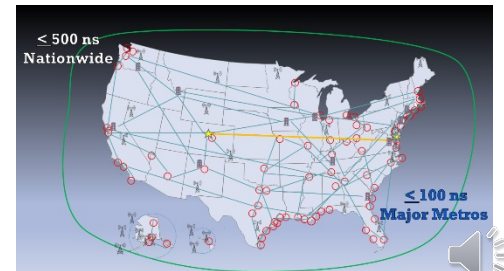




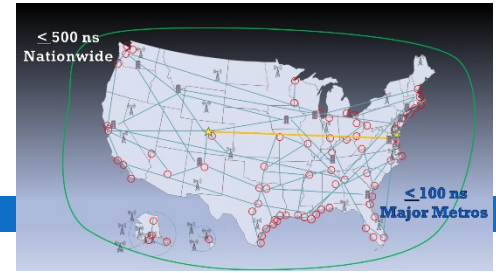


PNT a free utility



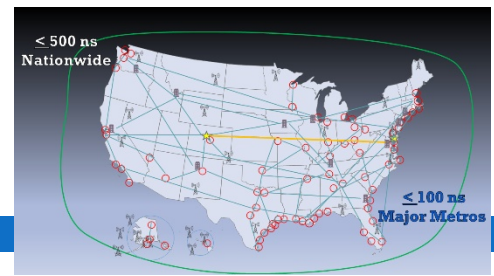


# Goal: Make Nation Safer





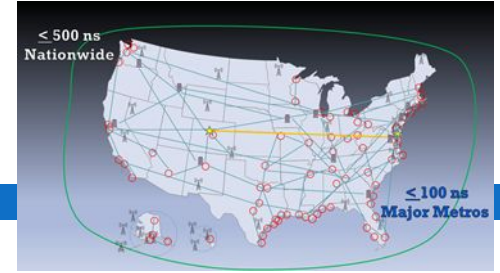
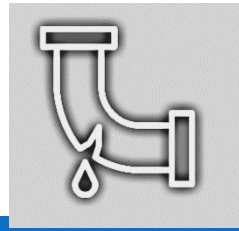
# Goal: Make Nation Safer



- Credible Alternative Sources



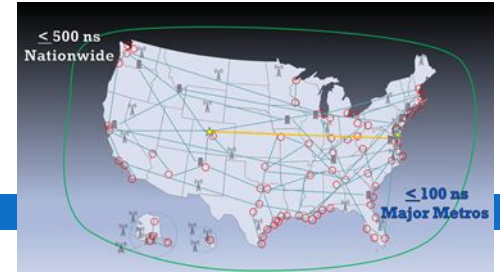
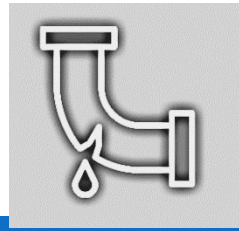
# Goal: Make Nation Safer



- Credible Alternative Sources
- Maximize Adoption & Use



# Goal: Make Nation Safer

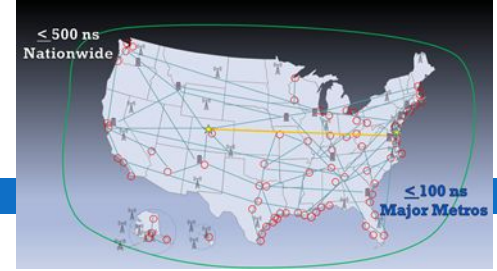
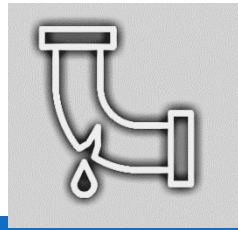


- Credible Alternative Sources
- Maximize Adoption & Use
  - Broad availability





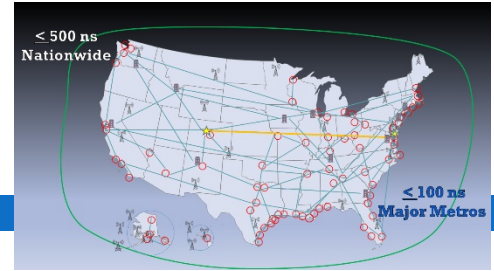
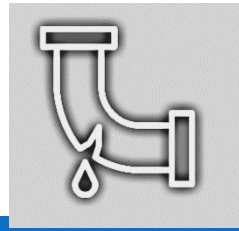
# Goal: Make Nation Safer



- Credible Alternative Sources
- Maximize Adoption & Use
  - Broad availability
  - Minimize barriers



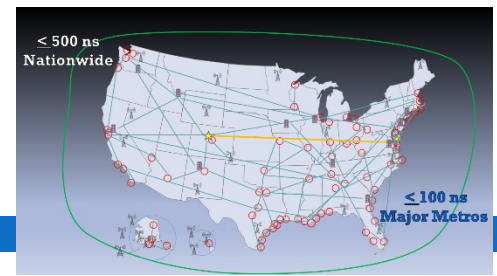
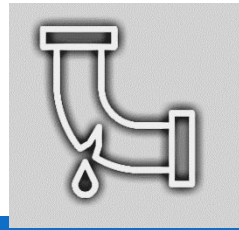
# Goal: Make Nation Safer



- Credible Alternative Sources
- Maximize Adoption & Use
  - Broad availability
  - Minimize barriers
  - Encouragement



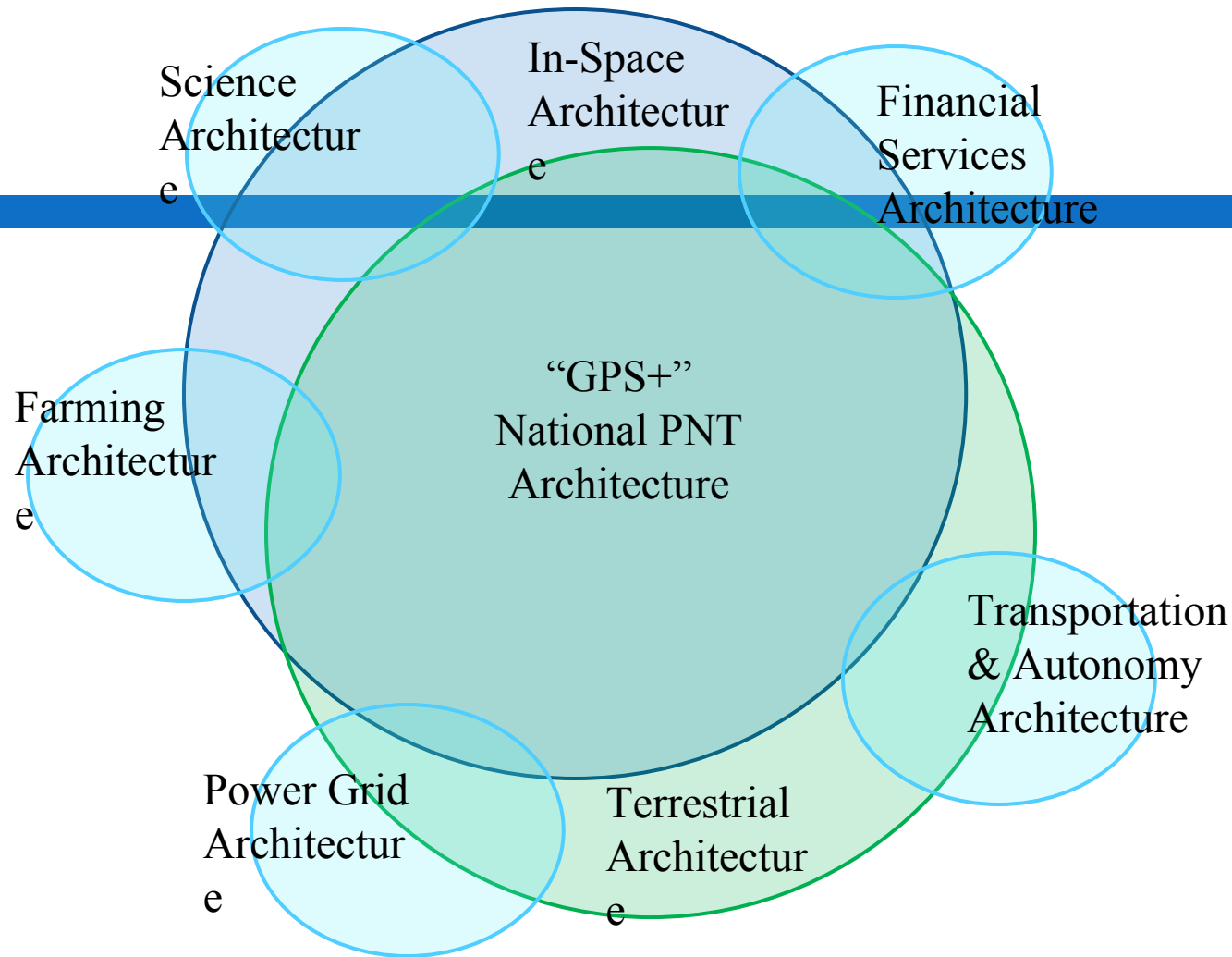
# Goal: Make Nation Safer



- Credible Alternative Sources
- Maximize Adoption & Use
  - Broad availability
  - Minimize barriers
  - Encouragement
  - Requirements

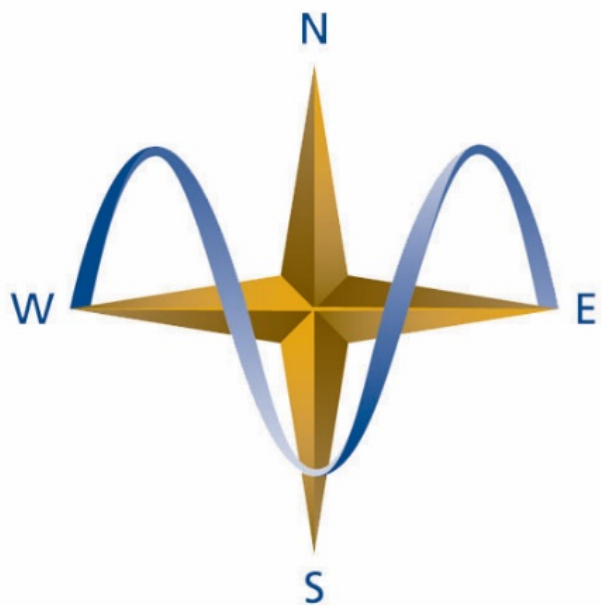






PNT  
Whenever,  
Wherever,  
However  
Needed





# RESILIENT NAVIGATION *and* TIMING FOUNDATION

The Resilient Navigation and Timing Foundation is a 501(c)3  
scientific and educational charity registered in Virginia  
[www.RNTFnd.org](http://www.RNTFnd.org)

