Discussion on regional radar network and radar exchange
(Weather Radar Maintenance)

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Trend of New Technology of the Solid-state Radar in Asia

<VIRAC>


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S-band Solid-state Transmitter

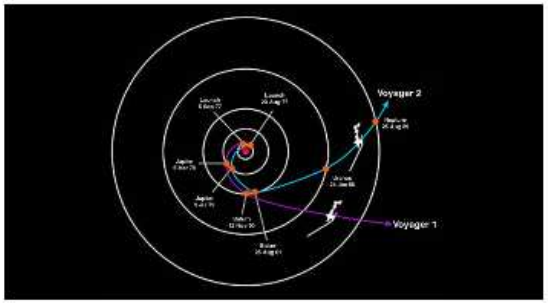
Solid State Amplifiers

Meteorological Radar (S-band) Solid-state Radar for Philippine (2012 – 2014)

What's a Solid-state Radar?
(Based on the Pulse Compression Technology)

1. History of development pulse compression

- Developed by NASA (Jet Propulsion Laboratory)
- First user was a Voyager. Interstellar spacecraft in 1977



Status

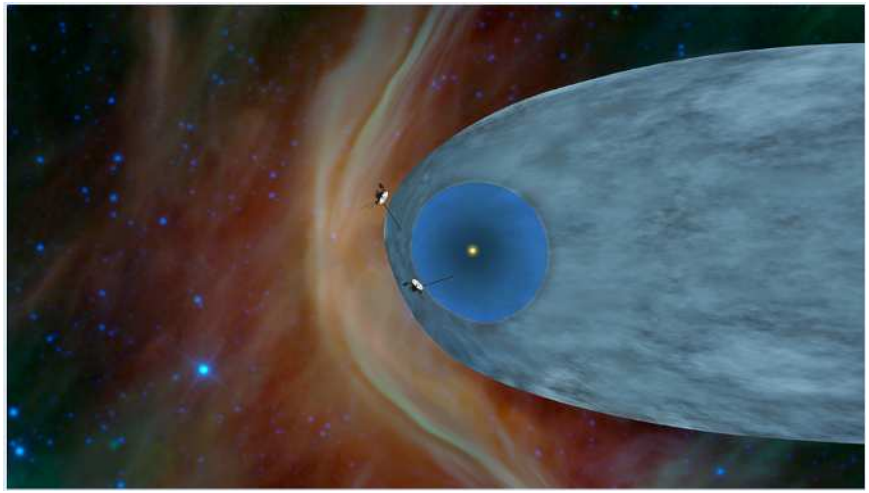
Science

The twin Voyager 1 and 2 spacecraft are exploring where nothing from Earth has flown before. Continuing on their more-than-40-year journey since their 1977 launches, they each are much farther away from Earth and the sun than Pluto. In August 2012, Voyager 1 made the historic entry into interstellar space, the region between stars, filled with material ejected by the death of nearby stars millions of years ago

2. Type of pulse compression method

- Direct sequence spread spectrum (DS)
- Chirp spread spectrum (Chirp)
- Hopping spread spectrum (HOP)

What's the Voyger's Mission?



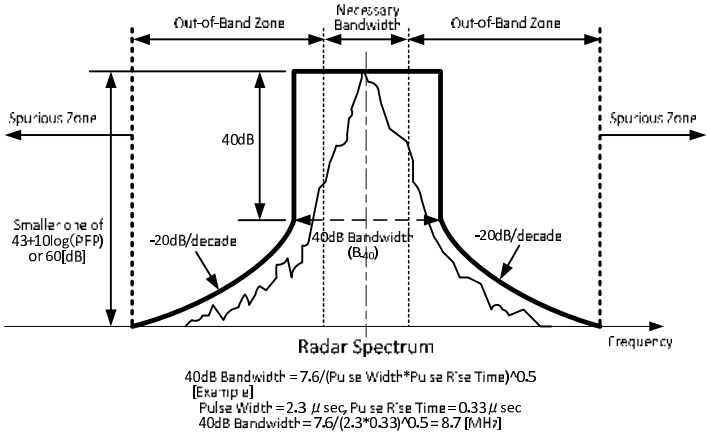
Interstellar Mission

The mission objective of the Voyager Interstellar Mission (VIM) is to extend the NASA exploration of the solar system beyond the neighborhood of the outer planets to the outer limits of the Sun's sphere of influence, and possibly beyond.

	Voyager 1	Voyager 2
Launch Date	Mon, 05 Sept 1977 12:56:00 UTC	Sat, 20 Aug 1977 14:29:00 UTC
Mission Elapsed Time	40:04:30:11:23:09 YRS MOS DAYS HRS MINS SECS	40:05:15:09:50:09 YRS MOS DAYS HRS MINS SECS
Distance from Earth	13,158,438,339 mi	10,910,106,778 mi
	141.55589410 AU	117.36878495 AU
Distance from Sun	13,119,974,888 mi	10,843,068,027 mi
	141.14211185 AU	116.64759523 AU
Velocity with respect to the Sun (estimated)	38,026.77 mph	34,390.98 mph
One-Way Light Time	19:37:17 (hh:mm:ss)	16:16:07 (hh:mm:ss)

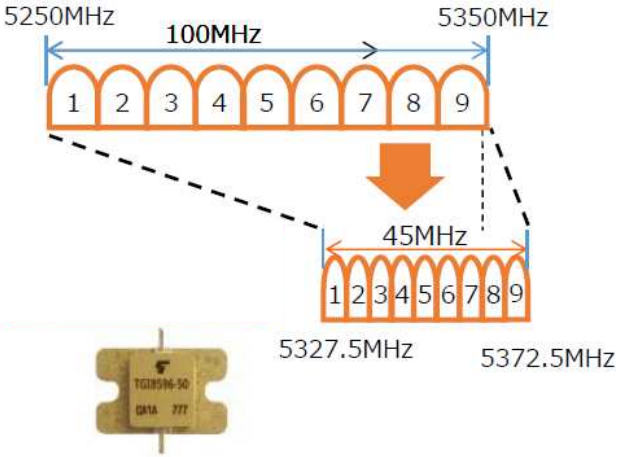
The Features of the Solid-state Radar

- To achieve a low power consumption.
- To save a frequency spectrum resources.



Spurious Zone and Out-of-band Zone for the Radar

- To save a maintenance cost and spare parts.



Radar Failure Modes: Results from the WMO Weather Radar Survey showing the main failure modes of a radar (2010)

Why does the Solid State Transmitter radiate a long pulse?

- Solid State Type Transmitter
  Peak Power : 10kW

-Electronic Tube Type Transmitter
Peak Power : 500kW

-Peak power : 500kw (Pulse width 2us)
Minimum detectable rainfall precipitation : 1 mm/hr (at 450km)

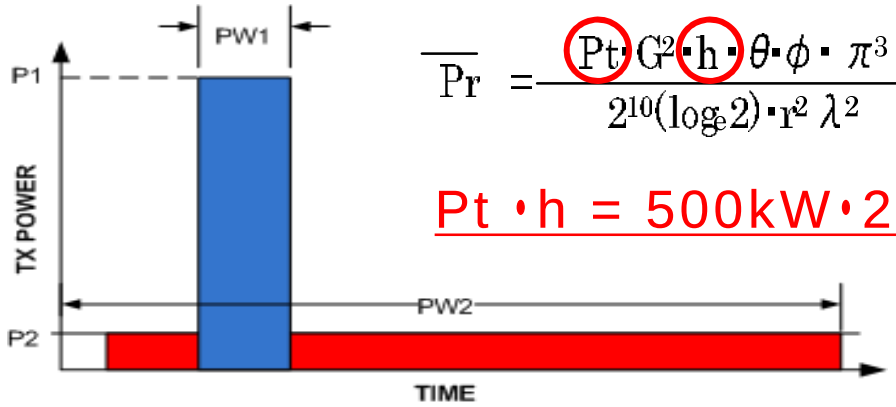
-Peak power : 10kw (Pulse width 2us)
Minimum detectable rainfall precipitation : 12 mm/hr (at 450km)

Problem!

Pulse width 2us → 100us

Solution!

-Peak power : 10kw (Pulse width 100us)
Minimum detectable rainfall precipitation : 1 mm/hr (at 450km)



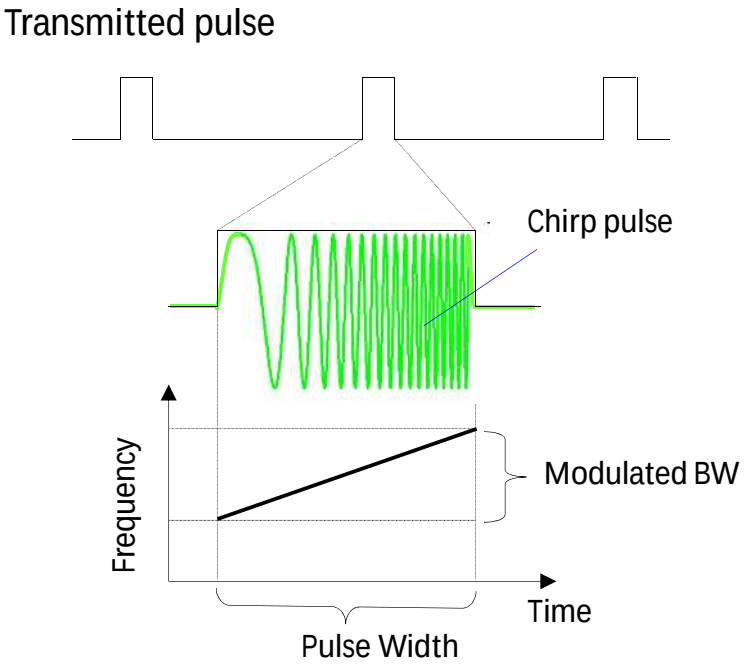
$$\overline{Pr} = \frac{Pt \cdot G^2 \cdot h \cdot \theta \cdot \phi \cdot \pi^3}{2^{10}(\log_e 2) \cdot r^2 \lambda^2} \left| \frac{\varepsilon - 1}{\varepsilon + 2} \right|^2 BR^{\beta} \cdot 10^{-0.1L} \cdot 10^{-0.2kg \cdot r}$$

Pt・h = 500kW・2us = 10kW・100us

Solid State Chirp Pulse Radar

■Transmitter

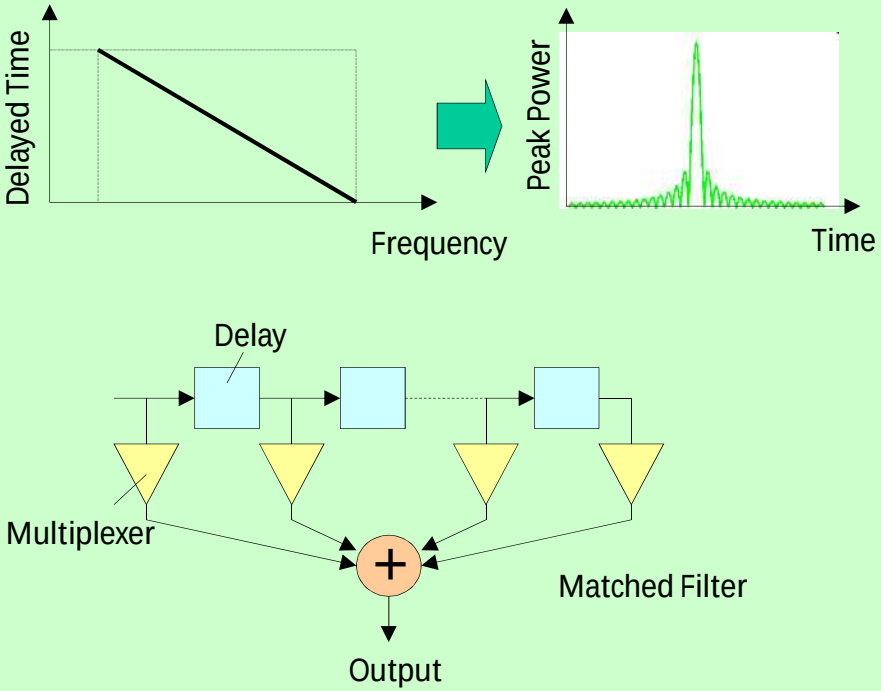
Chirp modulation pulse is transmitted.



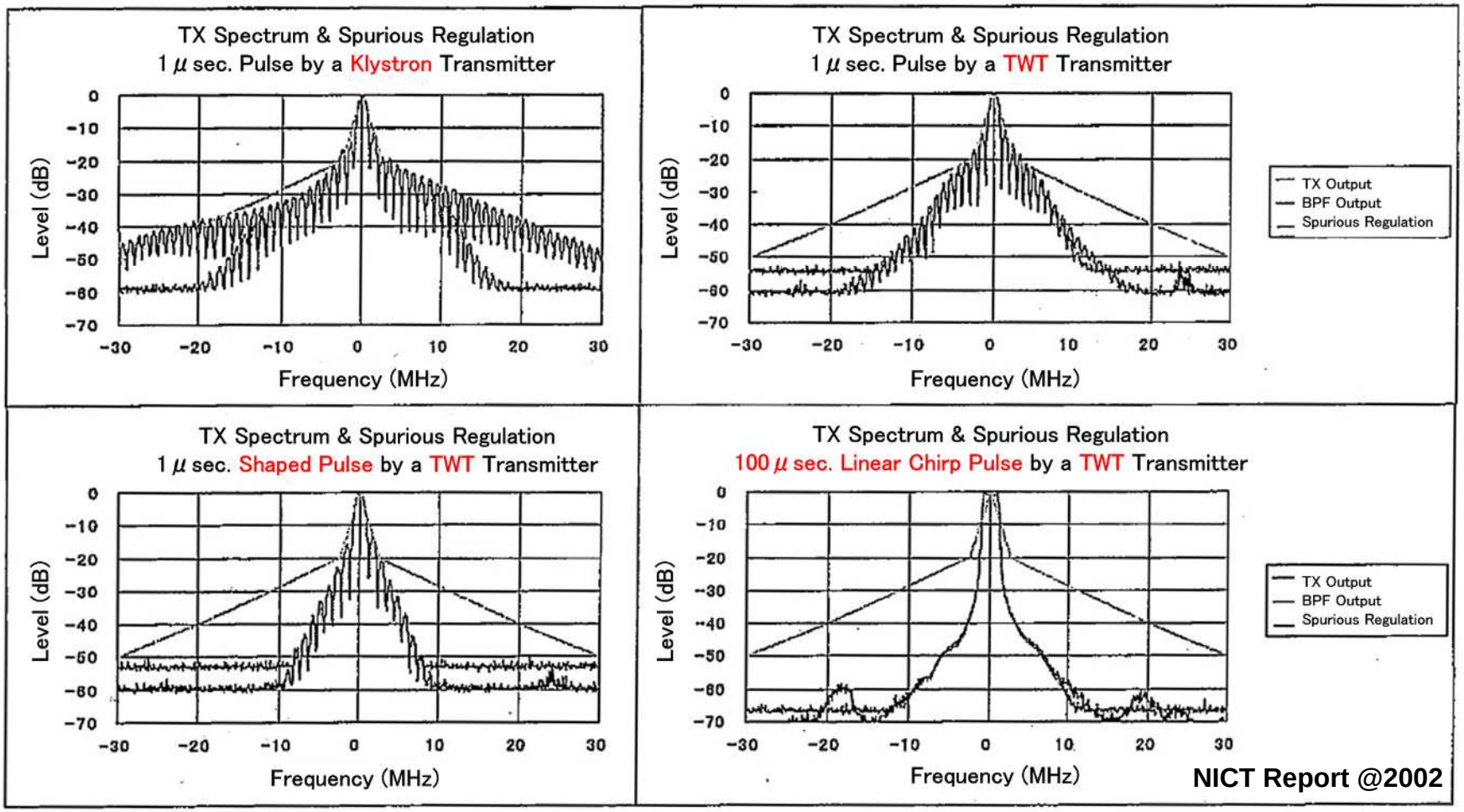
Linear Frequency Modulation(LFM)

■Receiver

Pulse Compression

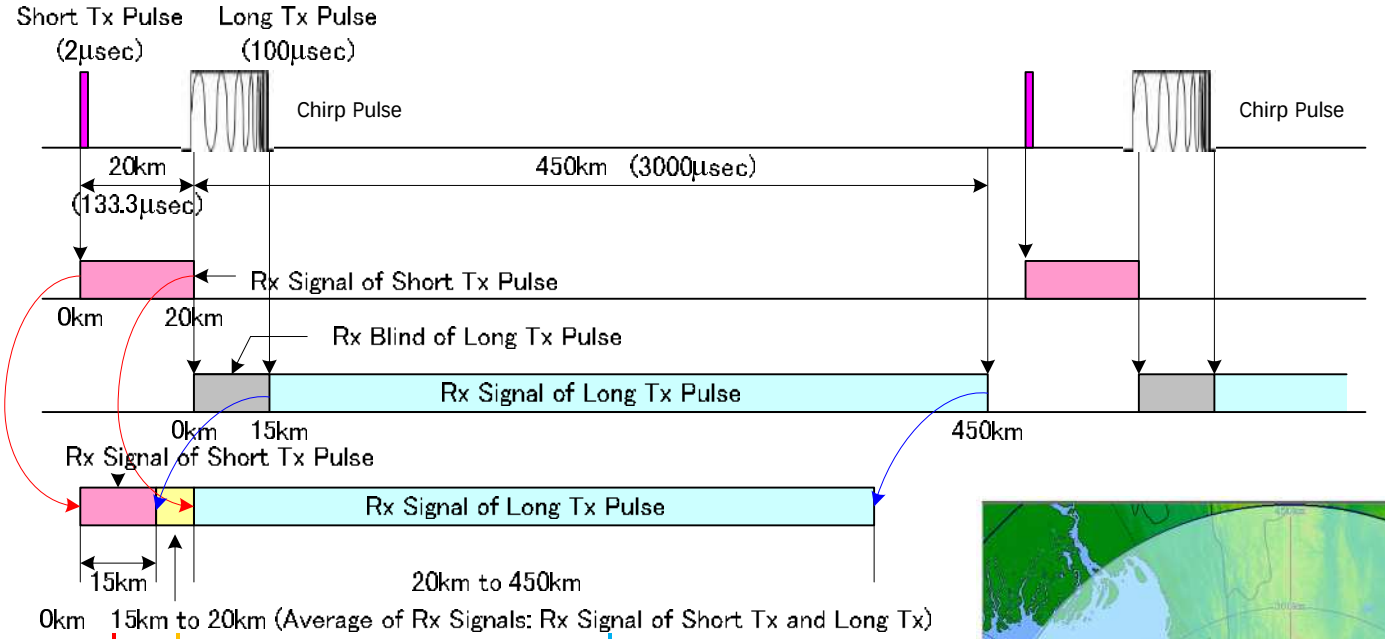


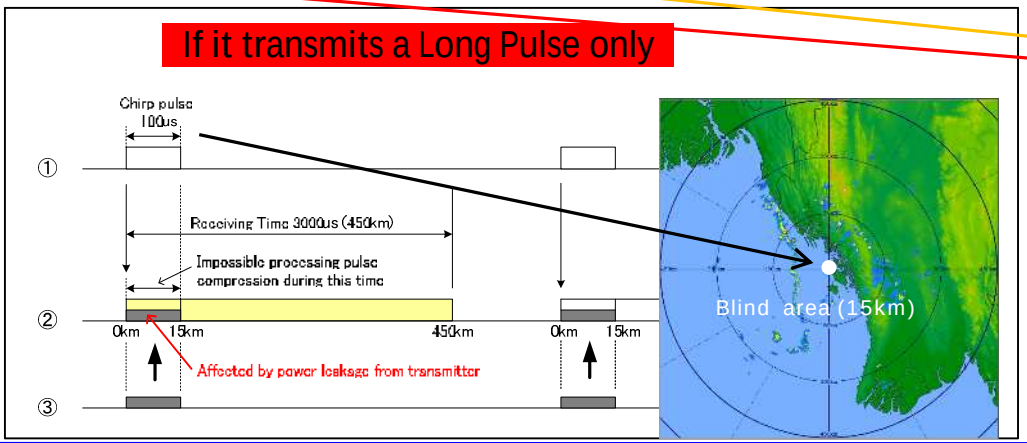
Less Interference and Low Spurious

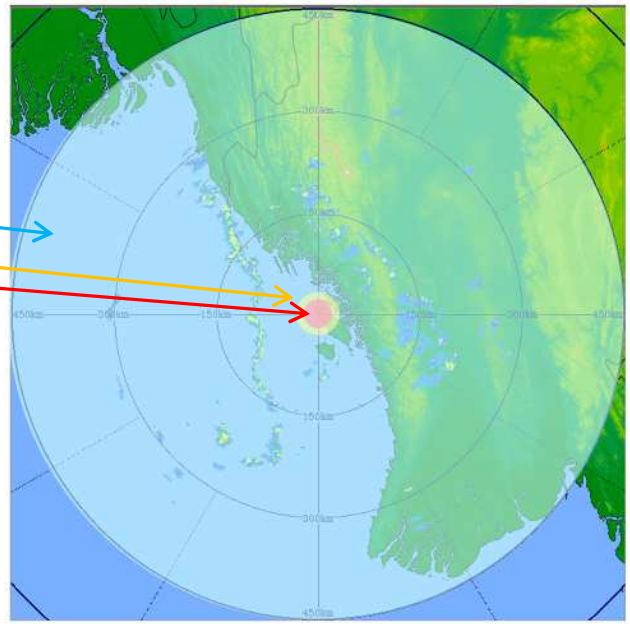


Note) TWT (Traveling Wave Tube) is one of amplifier for a transmitter as SSPA, but tube type.

Transmission Pulse of the Weather Radar (for SSPA type)







Solid State Radar
uses RF semiconductor devices for power amplification

- Quick equipment start-up, no preheating and tuning required

- Effective low transmitter output power 10kW (S-band)

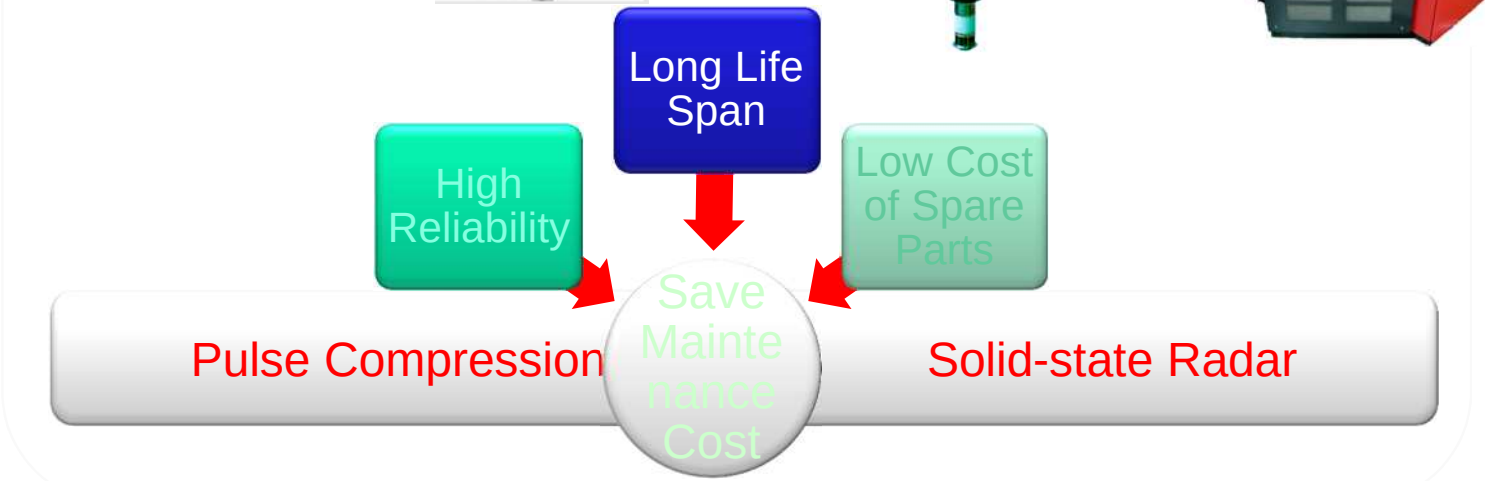
- Lower commercial power consumption, approx. 3kVA (S-Band)

- Compact and lightweight equipment, easy to maintain

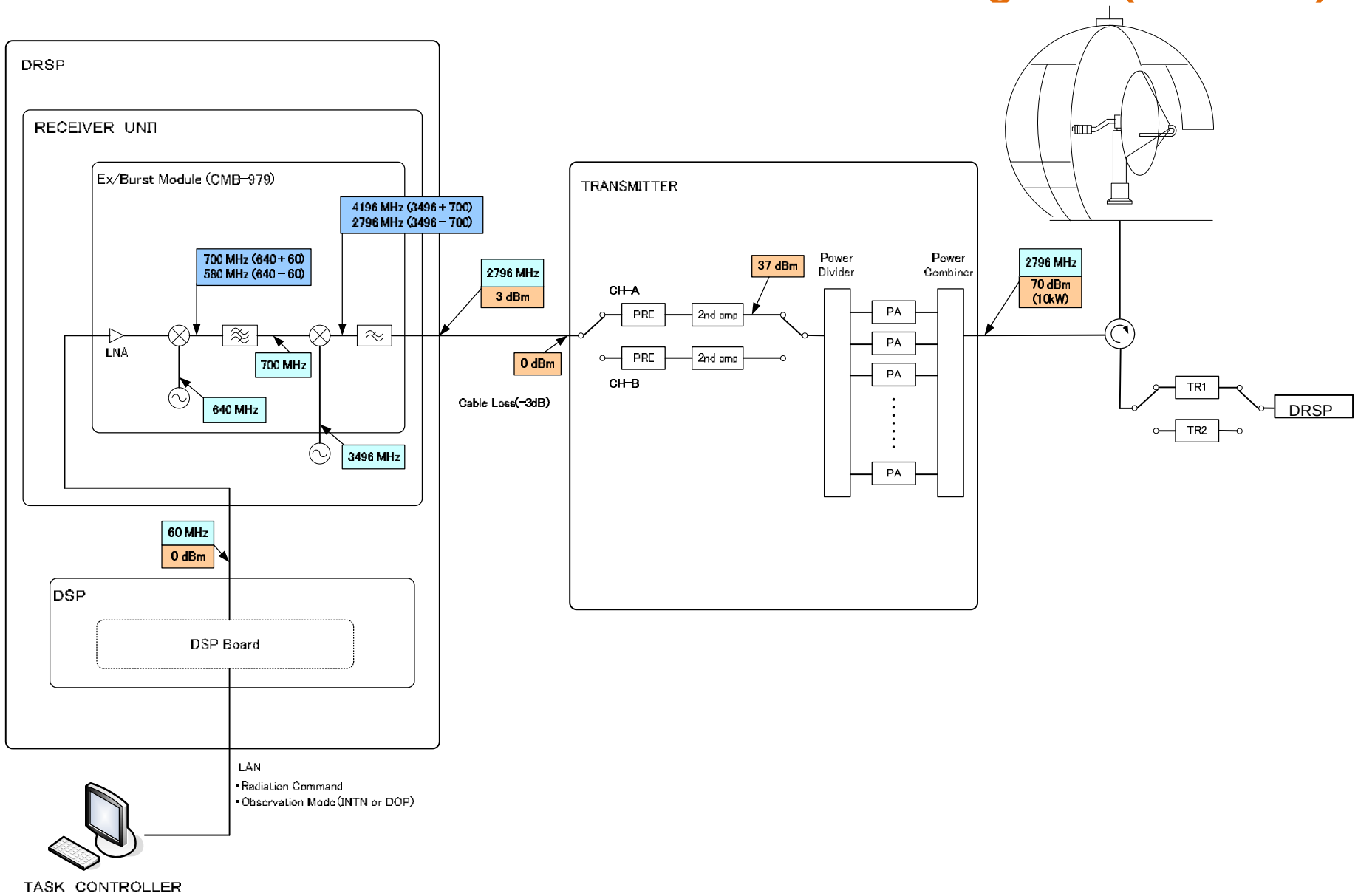
- SSPA life-span is more than 15 years

Comparison of the Conventional Radar and Solid-state Radar

	Magnetron	Klystron	Solid-state
Expected Life Span	8,000 hours	20,000 hours	128,000 hours
Replacement Cycle	One (1) year	Three (3) years	Fifteen (15) years
Transmitting Peak Power	500kW	500kW	10kW (equivalent approx.900kW
Replacement Time	Two (2) hours by two technicians	Three (3) hours by two technicians	One minute (None stop operation)



Solid-state Transmitter Schematic Diagram(S-band)



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