

# COMMERCIAL CREW TO ISS



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# *What Commercial Crew means to ISS*

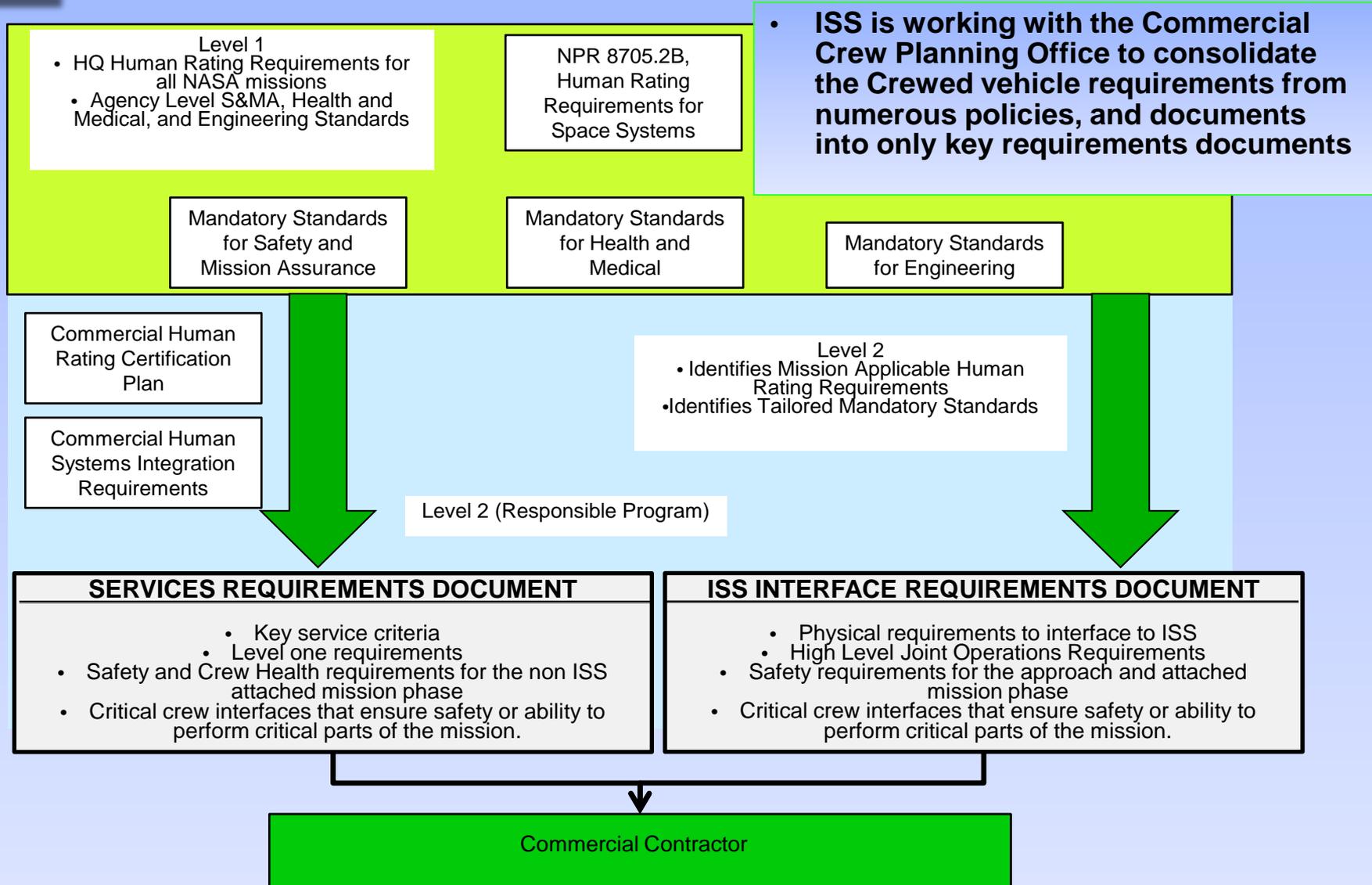
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- **US capability to transport crew members to & from ISS with rescue capability**
- **Dis-similar redundancy for crew transportation**
  - Protects the ability to launch ISS crews if one vehicle type has to stand down to address a systemic issue
    - > Soyuz carried crews post Columbia
- **Potential to reduce costs**
  - Currently only one provider in the world
  - One or more commercial providers would create competitive pressure on prices
  - Commercial Innovation has the potential to reduce costs.
- **Opportunity for NASA to reassess, streamline and restate requirements.**



# ISS Commercial Crew Requirements Definition





# ISS Commercial Crew Requirements

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- **High level ISS crew transportation requirements**
  - Transport up to 4 ISS crew members safely to ISS every ~180 days.
    - Crew ready to perform ISS tasks upon arrival
  - Safely return up to 4 ISS crew members to the US every ~180 days
    - Need early access to crew to provide medical care and perform human research data collections.
  - Provide an anytime crew rescue function
    - Lifeboat for crew in case of ISS emergencies such as fire, depressurization, or atmospheric contamination (1 in 115, for six month increment)
    - Transportation for a critically ill or injured crew member (1 in 285 probability, for six crew for one increment)
    - Need early access to crew for emergent medical care



# *Impacts from arriving/departing vehicles*



- **Every visiting vehicle has costs/impacts associated with it.**
  - **Engineering** to ensure ISS is ready to accept the vehicle
    - > Solar Array constraints
    - > Power Analysis during docking timeline
    - > Contamination due to pluming and off-gassing
    - > Logistics required for crew overlap time periods( A typical overlap of 10 days for crew of three is ~400 kg/yr)
    - > Propellant required to support attitude maneuvers to docking/undocking attitudes.
  - **Operations** to execute the ISS activities
    - > Planning
    - > Training controllers/ crew
    - > ISS MCC to commercial vehicle MCC Coordination
    - > Flight Rules development
    - > Execution



# *Impacts from arriving/departing vehicles*

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- **Crew time**

- > Prepack
- > Attitude Maneuver (usually 3 hours prior to docking)
- > Approach/ Departure monitoring
- > Vehicle configuration (depress vestibules, leak checks, etc.)
- > New crew orientation (safety, lay of the land)



For current baseline refer to  
SSP 54100 IDR Flight Program

# Flight Program Working Group (FPWG)

## Crew Rotation and Port Utilization Graphic – For Reference Only

NASA Official: Sean Fuller  
Prepared by: Scott Paul  
Chart Updated: Sept. 8<sup>th</sup>, 2010  
SSCN/CR: 12498 + 12465A

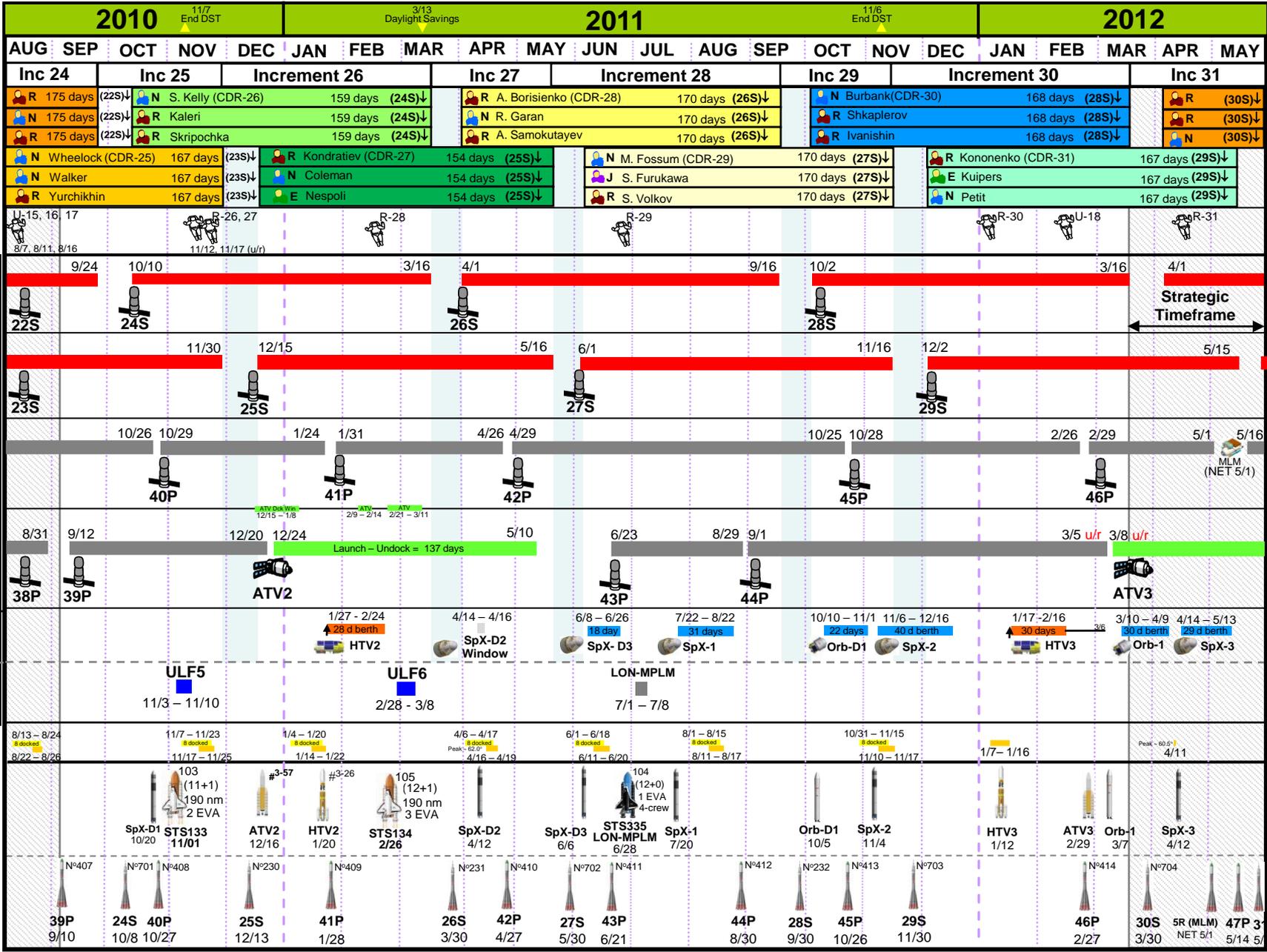


Crew  
Rotation

Stage EVA

Port Utilization

Launch  
Schedule



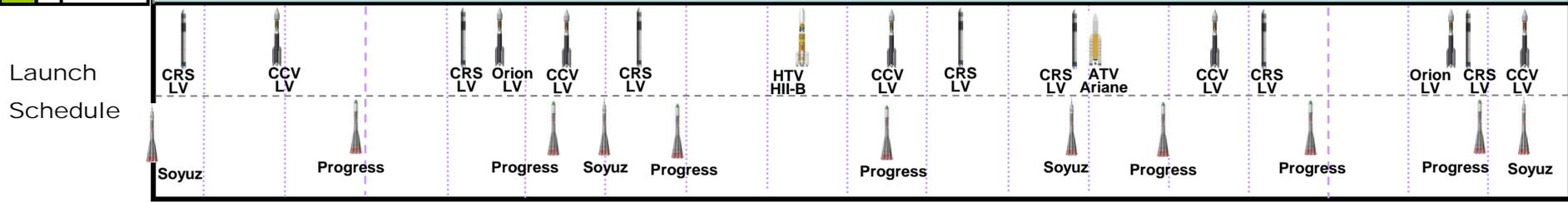
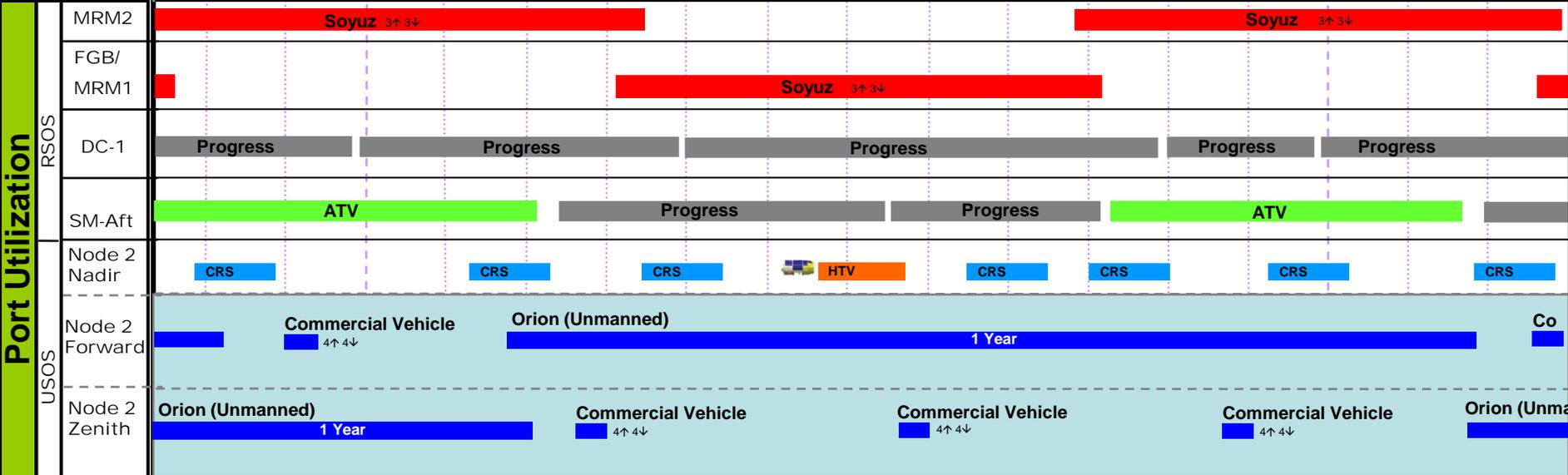


For current baseline refer to SSP 54100 IDR Flight Program

# Flight Program Working Group (FPWG)

Example Commercial Crew – For Reference Only

NASA Official: Sean Fuller  
 Prepared by: Scott Paul  
 Chart Updated: Sept. 10<sup>th</sup>, 2010





For current baseline refer to SSP 54100 IDRDR Flight Program

# Flight Program Working Group (FPWG)

Example Commercial Crew – For Reference Only

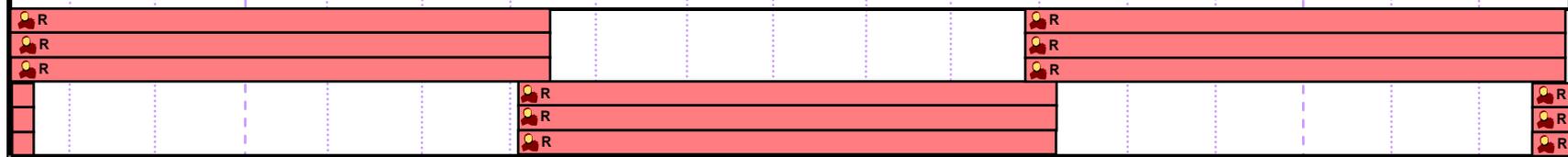
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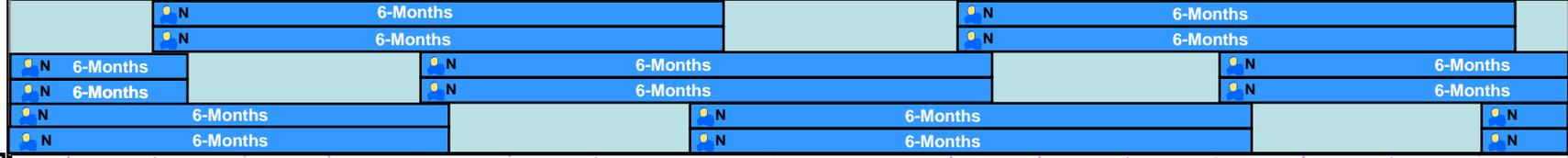
## Commercial Crew Option-2a

OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR

Soyuz

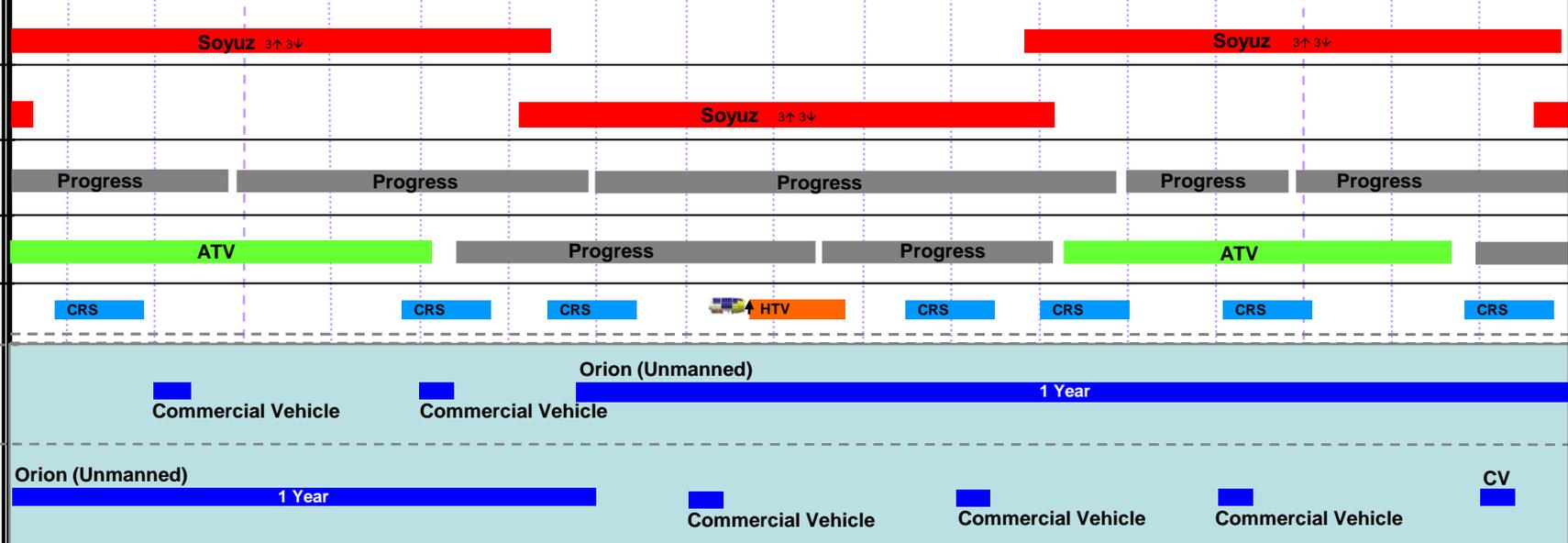


Commercial Vehicle

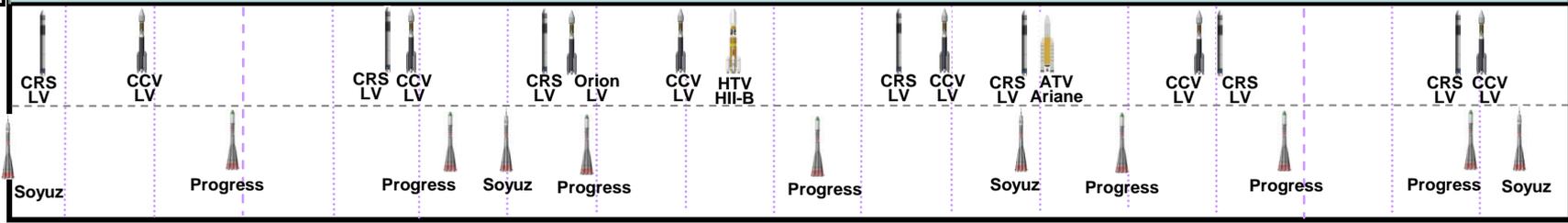


Port Utilization

RSOS  
 MRM2  
 FGB/  
 MRM1  
 DC-1  
 SM-Aft  
 Node 2 Nadir  
 USOS  
 Node 2 Forward  
 Node 2 Zenith



Launch Schedule





# Challenges

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- **Additional visiting vehicles beyond the minimum required have impacts to the ISS**
  - Increased total cost for transportation
    - > Cost per vehicle may go down, but total cost will go up (due to additional flights to ISS)
  - Increased propellant usage that must be resupplied at \$40,000/kg (~\$6 to \$13M/year)
  - Power balance while supporting the arrival/departure of a visiting vehicle results in a reduction or termination of payload activity.
  - The Microgravity environment of the ISS is affected for every arrival/ departure due to contact loads and propulsive attitude control.



# Challenges

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- **Additional visiting vehicles beyond the minimum required have impacts to the ISS (cont.)**
  - ISS crew time is required to support each arrival/departure. Based on current experience an additional vehicle will consume 25 crew hours which with two additional flights is 5% of the US utilization hours for a given 6 month increment or 10% of the National Lab/ Commercial allocation.
  - Commercial vehicle must arrive on its contracted date. Significant delays could risk decrewing ISS which greatly increases the likelihood of losing the ISS (10 times more likely to lose ISS when decrewed)



# Forward Work

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- **ISS Program will**

- Continue to define, streamline, and clarify with industry the ISS requirements for a crew transportation/rescue vehicle
- Define and request budget for initial operational flights in 2015.
  - > Protecting for backup Soyuz capability in 2015
- Develop docking system with delivery on orbit in 2014
- Continue to streamline ISS processes to increase Utilization for National Laboratory and Commercial customers