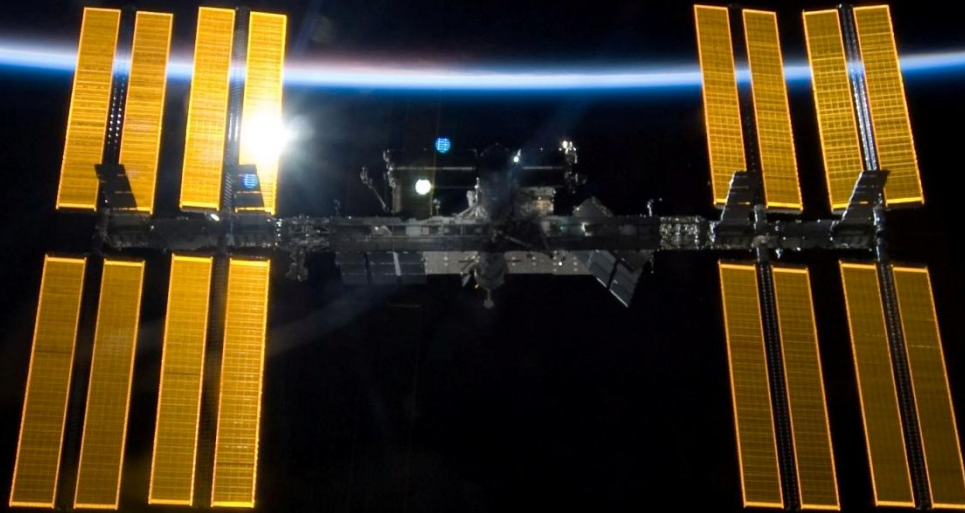


ISS - Enabling Exploration through Docking Standards



ISSMars-DC Conference
April 2011



C.A. Hatfield
Docking Systems Manager
International Space Station Program



Standards – Enabling Exploration



- **Connecting spacecraft from different nations has required unique development and expensive integration and test**
 - Apollo-Soyuz Test Project
 - International Space Station
- **Expansion of spacefaring nations (and non-governmental entities) will compound this issue in the future**
 - Exploration cooperation could be much easier with internationally accepted interface standards
- **One of the key elements involved in mating dissimilar spacecraft is docking systems**
 - Enabling dissimilar spacecraft mating for crew and cargo exchange
 - Enabling spacecraft assembly (e.g., APAS joining USOS and Russian Segments on ISS)



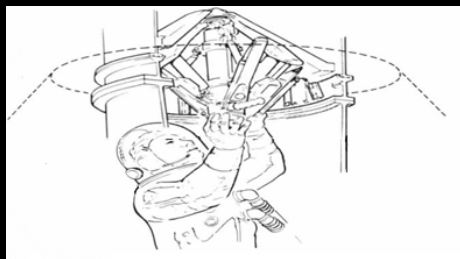
Enabling a Docking Standard



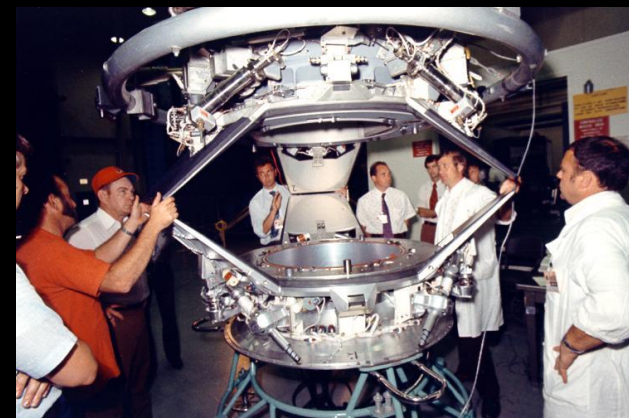
- **The ISS partnership has developed an International Docking System Standard (IDSS)**
 - An expanded version is expected to be approved in the second quarter 2011 by the ISS partnership
 - The latest version of IDSS can be found at <http://internationaldockingstandard.com/>
- **It is expected that several versions of IDSS compatible docking systems will eventual emerge**
 - Both NASA and ESA are currently developing systems
- **NASA will install an adapter to use this standard on the U.S. segment of ISS beginning in 2015**
 - The two new adapters will replace existing APAS adapters used by the Space Shuttle



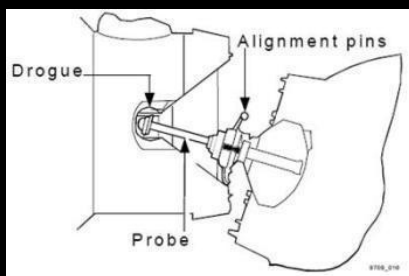
Docking System Early Design Progression



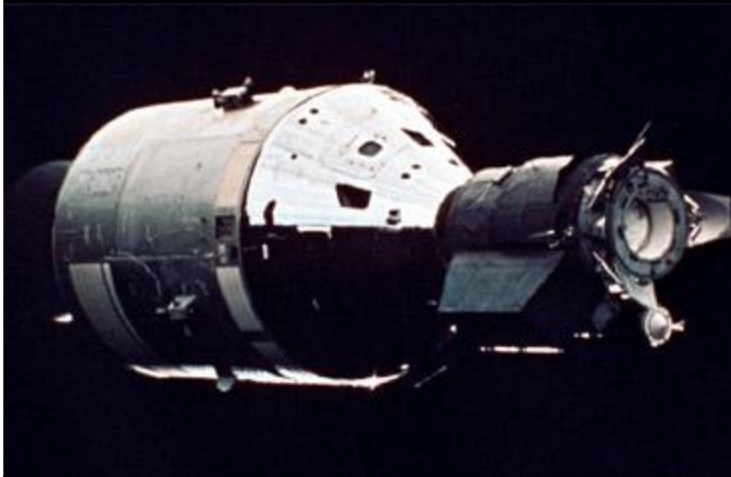
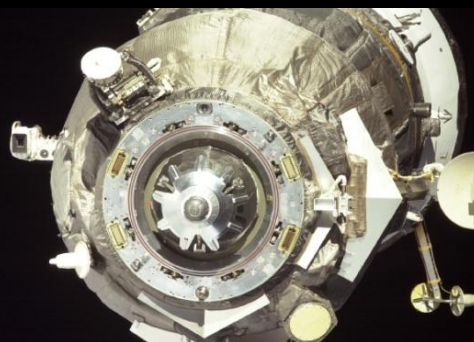
Apollo Probe Cone



Apollo Soyuz – the first androgynous system



Russian Probe Cone



(No scale is implied between figures)



Docking and Berthing



Docking

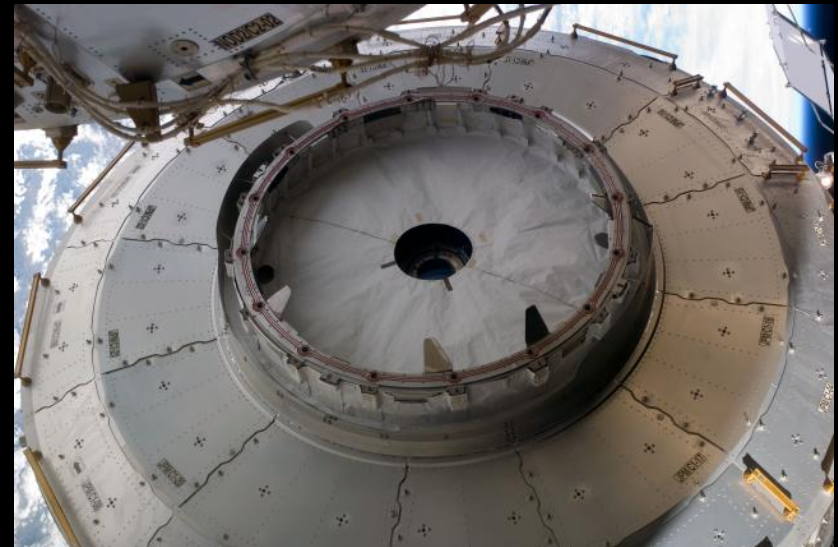
- Enables direct mating of vehicles
- Controlled by chasing vehicle
- Attenuates contact forces and moments

Berthing

- Large passageway and load carrying capability
- Ease of utility routing in pressurized volume
- Needs manipulator for installation



Androgynous Peripheral Attach System (APAS)



Common Berthing Mechanism (CBM)



Next Generation Systems and IDSS



- **Evolutionary**
 - Based on peripheral type architecture, incorporating proven hard capture system
 - Peripheral systems satisfy capture performance requirements for the widest range of vehicles (small crew capsules to orbiter like vehicles)
 - Peripheral systems allows for max pass through the docking interface without hardware dismantling
- **Androgynous**
 - Enables either vehicle to be the active “chaser”
- **Allows both docking and berthing**
- **Enables Low Impact technology**
 - All previous docking mechanisms have required the use of impacts (i.e. velocity or post-contact thrusting) to create the energy required for soft capture mechanism interface alignment and capture between mating docking interfaces
 - Low impact technology can accommodate wide range of vehicle contact and capture conditions



NASA ISS Docking System Policy



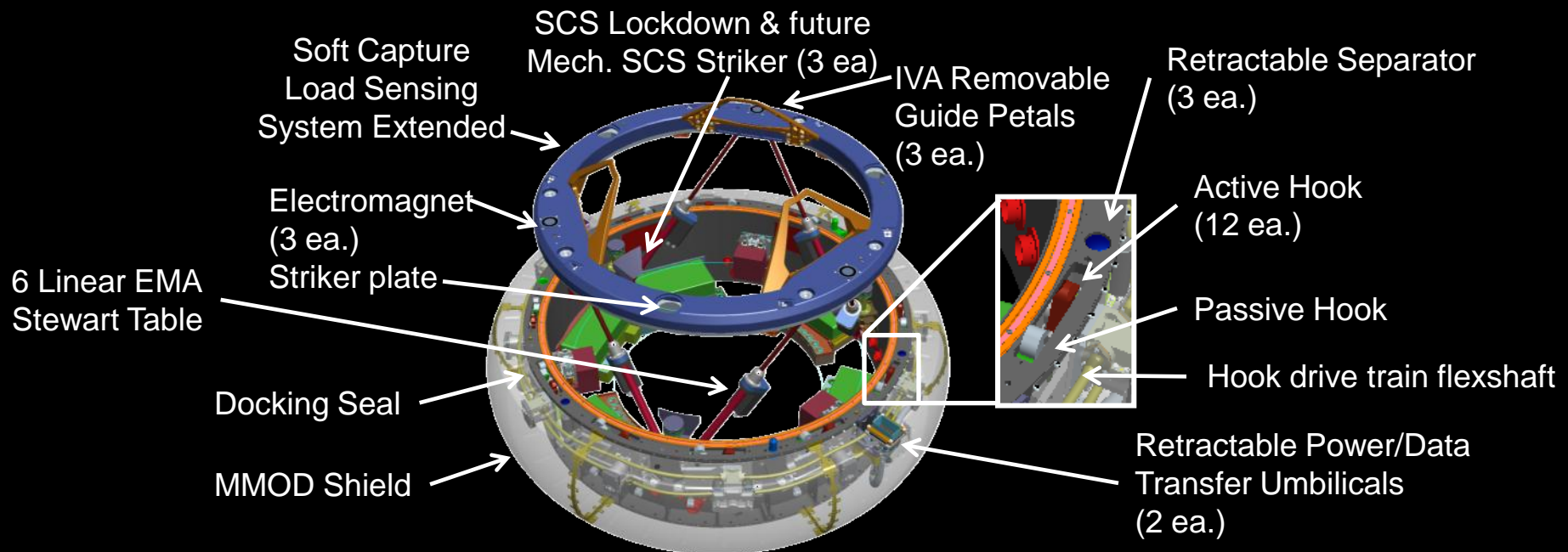
- **NASA plans to use the International Space Station as the first use of the IDSS**
 - Will be the docking system used on the U.S. segment of the ISS for all visiting vehicles
- **All vehicles visiting the USOS will be required to be IDSS compliant**
- **NASA is building and qualifying the NDS system as reference design**
- **NASA will provide the NDS data package to commercial vehicle providers having agreements with NASA to provide services, who can**
 - Build their own design
 - “Build to print” the NDS design
 - Buy the system from the production vendor
 - Request NASA provision the NDS



NASA Docking System – Features



- Low Impact six degree of freedom force feedback platform for soft capture
- IDSS Compatible
- Simple interfaces to host vehicle
- Block development with a family of configurations planned





ISS Docking and Berthing Ports



NDS installation will update existing APAS systems on PMAs to be IDSS compatible

Planned NDS (IDSS): 2

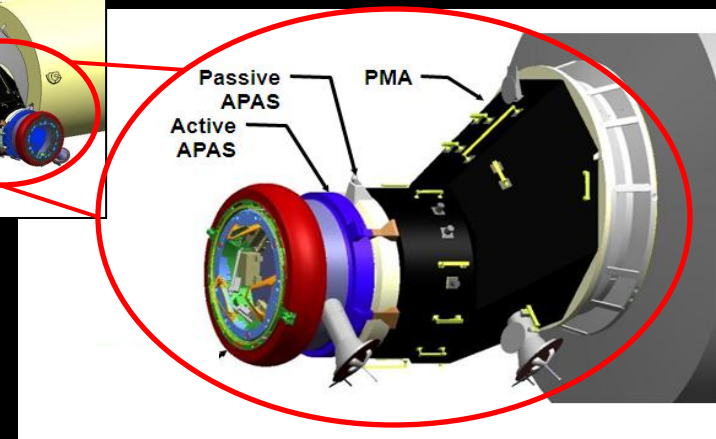
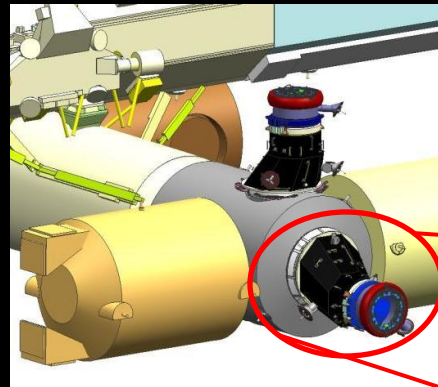
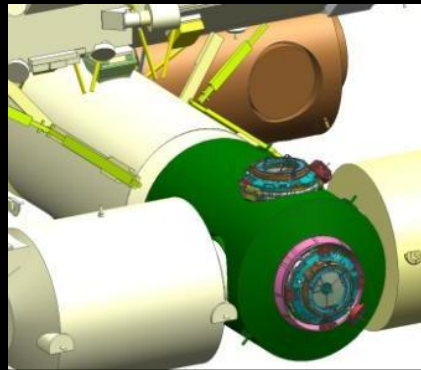
Berthing Ports: 2

Probe & Cone: 4





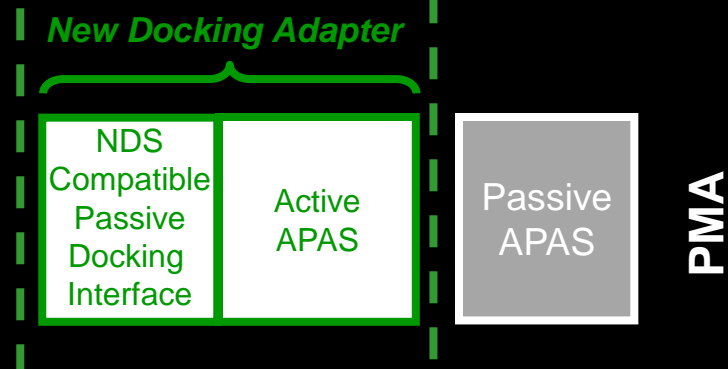
New Docking Adapter Configuration



- Until recently, new CBM-based adapters were planned for ISS
- Change was made to use existing Pressurized Mating Adapters (PMA) as a base for the new adapters
 - Provides greater clearance for winged vehicles
 - Frees an additional CBM port for potential use

*New
ISS Interface*

*Existing
ISS Interface*





NDS and Docking Adapter Status



- **NASA is working closely with the ISS partnership to further refine the IDSS standard**
 - Further revisions after the upcoming release are not anticipated in the near future
 - NDS team is collaborating with other agencies to agree on remaining interface features (e.g., connectors)
- **NDS design kicked off CDR this week**
 - Long lead part procurement underway
 - Flight representative EDU assembly early 2012
 - Qualification program begins late 2012, complete 2013
- **ISS Docking Adapters planned for launch beginning in 2015**
- **<http://dockingstandard.nasa.gov/documents.html>**



Summary



- **NASA and the ISS partnership are jointly developing a key standard to enable future collaborative exploration**
- **The IDSS is based on flight proven design while incorporating new low impact technology**
 - Low impact technology accommodates a wide range of vehicle contact and capture conditions
- **This standard will get early demonstration on the ISS**
- **Experience gained here will enable operational experience and the opportunity to refine the standard**
- **NASA and ESA are developing new docking system; others are expected later**
 - ESA: IBDM
 - NASA: NASA Docking System (NDS)



Backup



Block 0 System Configurations Summary



-301/Core

- Active, Fully Androgynous*, 120VDC power, integrated electronics
 - Configuration can dock in either active or passive mode to all configurations or to any IDSS compatible system

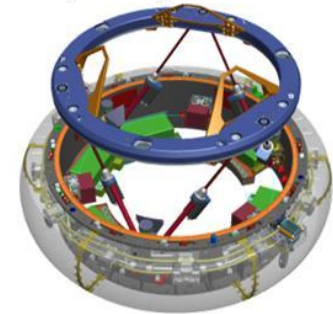
-302/Short

- Reduced height; electronics boxes remotely mounted
- Current NDS ISS adapter and Hub baseline
- *Note: This configuration detailed features are under review*

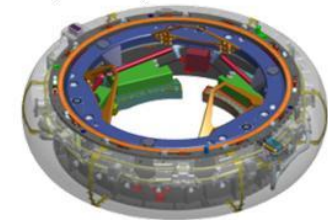
-303/Lower Voltage

- Same as -301 except 28VDC power input
 - -301 avionics was designed to support power board swap out; board has not been designed

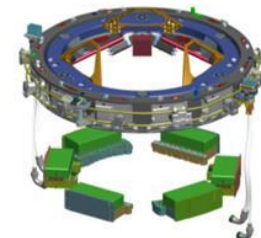
Ready to Dock (Active Mode)
Soft Capture System Extended



Ready to Dock/Launch
(-301 Passive Mode)
Soft Capture System Retracted



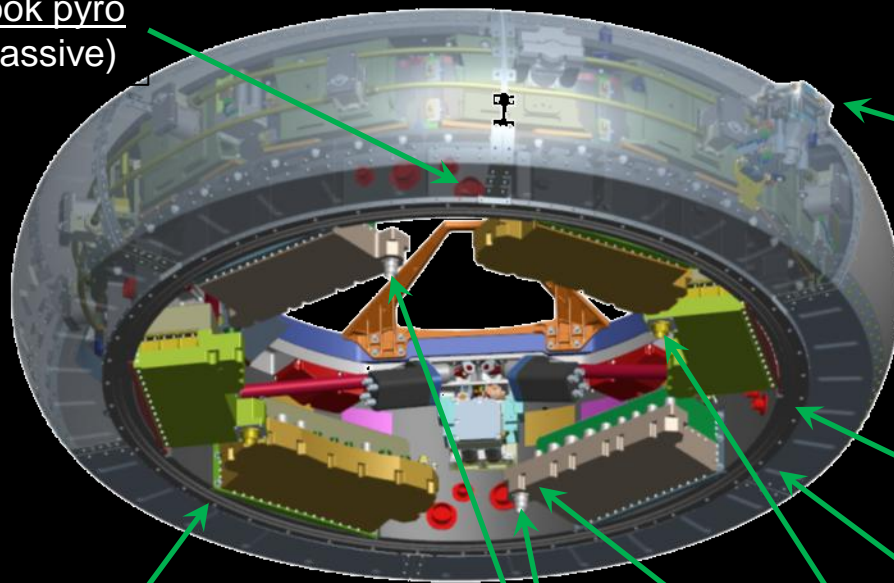
Ready to Dock/Launch
(-302 Passive Mode)
Electrical Boxes mounted in host



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NDS-to-Host Vehicle Interfaces



Vehicle to hook pyro
2 x (Active/Passive)

Docking Umbilicals

2 x ISS FRAM type connectors
(Channel A/B), each has:

- Two 8 AWG power circuits w/ both
 - MIL-STD-1553B
 - 100 Base T Ethernet

All wiring passed thru to inside of tunnel for host

Seal I/F

Two concentric seal beads
(NDS provides)

Electrical Bonding

NASA-STD-4003, Class R/H

NDS Power

2 Connectors for 120V (or 28v) feeds
(A/B) for system and heater power

NDS Data
2 x TIA-422-B or
MIL-STD-1553B
(A/B)

Structural I/F

48-bolts on 53.150" (1350 mm) DIA
BC (thru holes on NDS, inserts on
host, NDS provides bolts)
3 shear pins different than

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NDS Mass Status



	-301			-302***		
Title/Description	Base Mass	Basic Mass + MGA	Avg MGA	Basic Mass	Basic Mass + MGA	Avg MGA
Allocated Mass	n/a	750	N/A	n/a	704	N/A
System Roll-up*	679.65	744.31	10%	630.65	684.54	9%
Hard Capture System (HCS)**	480.43	527.39	10%	357.39	387.01	8%
Soft Capture System (SCS)	135.16	147.20	9%	135.22	147.27	9%
*System Roll-up mass includes top components assembled at a higher level than the HCS and SCS sub-assemblies **Box masses below are included in the Hard Capture System Mass Above. The same boxes are used in -301 & -302 ***302 Mass does not include host provided h/w (MMOD shield, box mounting, extension cables, etc.)						
Control Box Assy** (Qty 2)	31.51	34.39	9%	31.51	34.39	9%
Motor Box Assy** (Qty 2)	34.05	37.04	9%	34.05	37.04	9%
Power Box Assy** (Qty 2)	45.35	49.39	9%	45.35	49.39	9%

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