- space**ROS**



An open-source framework for developing flight-quality robotic and autonomous space systems

Ivan Perez KBR @ NASA Ames Research Center ivan.perezdominguez@nasa.gov

- space**ROS**



An open-source framework for developing flight-quality robotic and autonomous space systems

Ivan Perez KBR @ NASA Ames Research Center ivan.perezdominguez@nasa.gov



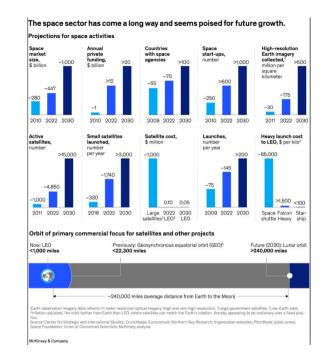
Agenda

- Motivation
- Goals
- What is Space ROS?
- Status
- Next steps



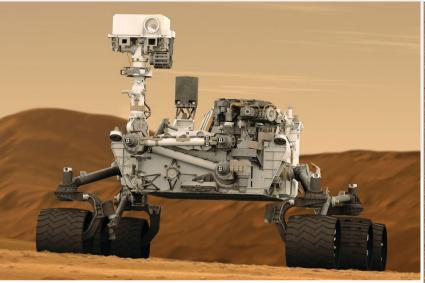
Space Industry

- Space sector growing rapidly
- Projected by 2030:
 - \$1T market size
 - \$20B in private funding
 - > 100 countries with space agencies
 - > 1000 Space startups
 - 3x number of satellites by 2030
- Robotics is Key for Long-term Space Operations





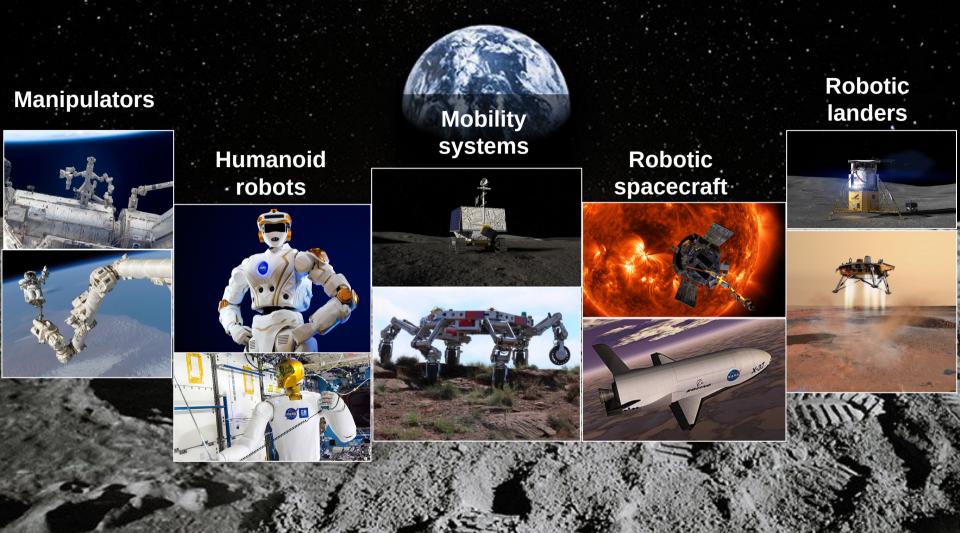




Robots are already in space









1970 – joystick control

2020 – 2M lines of code



Increasing amount of software + cost of software development = demand for reuse

The Demand for Reuse

The space community is moving toward componentbased, modular, reusable, and open frameworks for flight software and mission control

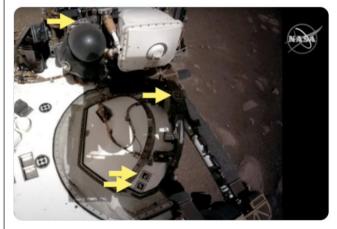
- core Flight System (cFS) aerospace applications
- Robot Operating System -- robotics applications
- F' (F Prime) aerospace applications
- Yamcs command / control of spacecraft
- OpenMCT data visualization

Also using smaller open source projects in flight

 AprilTag (visual fiducial system) used on Perseverance

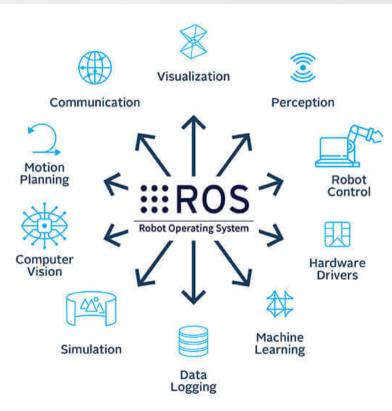


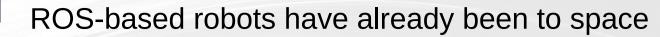
Dear @NASAPersevere, what an amazing landing! Congratulations! My joy trebled when I saw that you have a number of AprilTag visual fiducials on board (github.com/AprilRobotics/...). I pulled out the AprilTag iOS app, enabled the 16h5 tag family, and was able to read these tags!



6:44 AM · Feb 23, 2021 · Twitter Web App









space**ros**

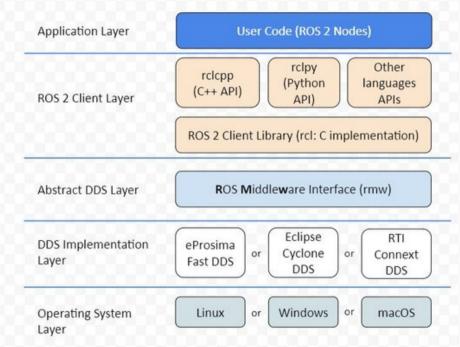
2014: Robonaut 2



2019: **Astrobee**



ROS 2 Architecture Overview

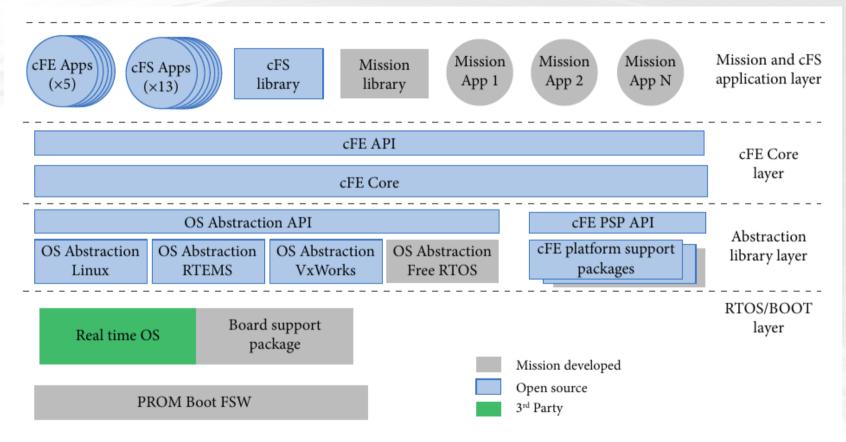


DDS = Data Distribution Service is a decentralized, publish-subscribe communication protocol. rmw = ROS Middleware Interface hides the details of the DDS implementations.

Use rclcpp for efficiency and fast response times, use rclpy for prototyping and shorter development time.

Source: https://automaticaddison.com/ros-2-architecture-overview/





NASA cFS Software Layers and Components. Source: NASA, 2014.



Space ROS

An open-source space robotics framework for developing flight-quality robotic and autonomous space systems

space**ROS**

A space-certifiable and reusable robotics framework

- Facilitate reuse across missions, reducing development effort and costs
- Support certification to flight software standards, like NASA's NPR7150.2 and DO-178C
- Provide artefacts to allow space robotics projects to gain a head start
- Aligned with NASA so that it can be adopted for missions
- Enable rapid development of new robotic capabilities that reduces cost and time-to-market
- Based on open community, frameworks, and standards

What is Space ROS?

Procedure

- Planning Committee
- Technical Committee
- Standards Group

Technology

- Earthly/Docker images
- Sample applications
- Simulation tools & assets
- V&V tools
- Continuous Integration
- Dashboard
- Process compliance tools
- Embedded targets

Infrastructure

- Website
- Code repository
- CI server
- Docker hub
- Forums
- Documentation

Community

- Outreach
- Fixes and backports to ROS 2 project
- Community engagement

Committees

Funded in part by the Announcement of Collaboration Opportunity (ACO) program within NASA's Space Technology Mission Directorate and Blue Origin Advanced Development Programs

At the end of the ACO, OSRF designated PickNik Robotics as lead of the Planning and Technical Committees. PickNik is also using Space ROS in Phase I SBIR currently ongoing with NASA JSC.

Other members of the planning and technical committees include members from NASA, JAXA, KBR, Technology Innovation Institute (UAE), Traclabs, Emergent Space, Motiv, OSRF, Lockheed Martin, SWRI, and others.

*The mention of these companies does not imply endoresement of, or by, any of the institutuions or organizations mention.

What is Space ROS?

Procedure

- Planning Committee
- Technical Committee
- Standards Group

Technology

- Earthly/Docker images
- Sample applications
- Simulation tools & assets
- V&V tools
- Continuous Integration
- Dashboard
- Process compliance tools
- Embedded targets

Infrastructure

- Website
- Code repository
- CI server
- Docker hub
- Forums
- Documentation

Community

- Outreach
- Fixes and backports to ROS 2 project
- Community engagement

Technology (ongoing)

ltem	Description
Docker images	Docker images provide a reproducible environment used by developers, our own CI infrastructure, and our demos.
Sample applications	Incorporate navigation (Curiosity Rover) and manipulation (Candarm) demo applications.
Simulation tools & assets	Incorporate space-related simulation assets that can then be available for use by Space ROS code.
V&V Tools	Code analysis, static analysis, assurance, etc. Some of the tools are integrated with SARIF and the build process, so that errors reported by the tools can be traced back to the code and accessed directly in VS Code.
Dashboard	Integration of SARIF output from analysis tools into VS Code.
Process compliance tools	Tools that analyze compliance with NPR 7150.2 and report potential violations.



Space ROS Docker Images

https://hub.docker.com/r/osrf/space-ros



osrf/space-ros Sponsored OSS ☆

By Open Source Robotics Foundation • Updated 2 months ago Docker images for the Space ROS project https://github.com/space-ros

Overvie	w Tags		
Sort by	Newest -	Q	
TAG <u>lates</u> Last p	t ushed 2 months ago by <u>osrfbot</u>		docker pull osrf/space-ros:latest
DIGES <u>d261</u>	T 70bdb6ee	OS/ARCH linux/amd64	COMPRESSED SIZE 0 943.02 M



Space ROS Releases

Releases / humble-2023.10.0	
humble-2023.10.0 (Latest	ompare 👻 🖉 🖞
n ivanperez released this Nov 3 🔊 humble-2023 Schdef 3 🥝	
▼Assets 2	
[]Source code (zip)	Oct 10
Source code (tar.gz)	Oct 10
ⓓ 🖉 I people reacted	

humble-2024.01.0 현 Due by January 31, 2024 @Last updated

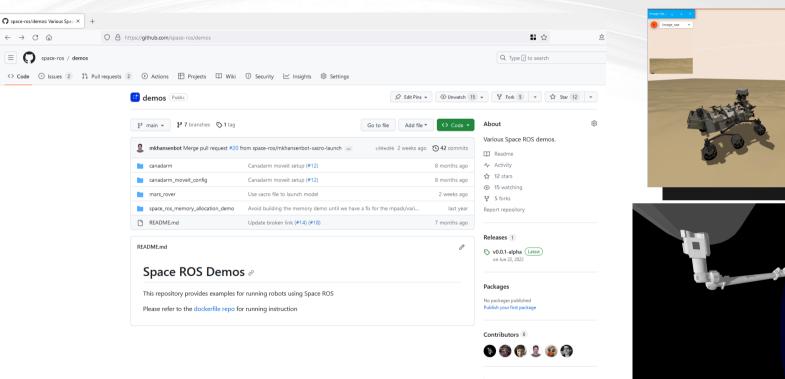
5% complete 17 open 1 closed

Edit Close Delete



Space ROS Demos

https://github.com/space-ros/demos



Languages

C++ 50.3%
 Python 37.1%
 CMake 9.1%
 C 3.5%

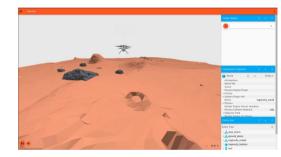


NASA Spark

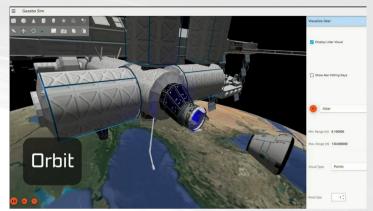


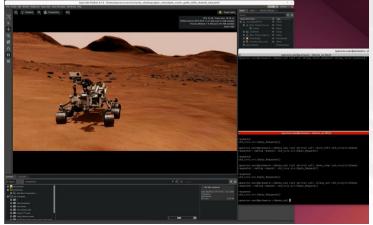












Static Analysis

- Increase code quality, ease verification
- Space ROS provides a suite of static analyzers, including IKOS and Cobra from NASA
- Currently adding dynamic analysis: code coverage and MC/DC testing
- The static analysis tools generate SARIF output
 - Most by parsing output of the tool
 - Tools should eventually support SARIF directly; would allow for more detailed information in SARIF, such as logical location
- Filtering pass to remove (some) redundancy
 - Currently, removing identical issues
 - Would like to remove semantic equivalents
- The results are made available to the Space ROS Dashboard
 - An archive format that contains analyzer output, filtered output, and metadata

```
if (count == 0) {
               /* If no matches, then just duplicate the string. */
           #if defined( MSC VER)
з
           #endif
               strcpy(ret, str); // NOLINT
           #if defined( MSC VER)
           #endif
             } else {
               /* Otherwise. duplicate the string whilst performing
                * the replacements using the position cache. */
               pret = ret;
               memcpy(pret, str, pos cache[0]);
               pret += pos cache[0];
               for (i = 0; i < count; i++)
                 memcpy(pret, to, tolen);
                 pret += tolen;
                 pstr = str + pos cache[i] + fromlen;
                 cpylen = (i == count-1 ? orglen : pos cache[i+1]) - pos cache[i
                 memcpy(pret, pstr, cpylen);
                 pret += cpylen;
     133
Δ
               ret[retlen] = '\0';
           end repl str:
             /* Free the cache and return the post-replacement string,
              * which will be NULL in the event of an error. */
             allocator->deallocate(pos cache, allocator->state);
             return ret;
           // *INDENT-ON*
           #ifdef cplusplus
```

	∽ — clang-analyzer	-security.insecureAPI.D	eprecatedOrUnsafeBufferHandling
	🛕 107 🛛 split.	c	snprintf(string_array->
	🛕 123 char_	array.c	memcpy(char_array->l
	🛕 125 🛛 repl_	str.c	memcpy(pret, str, pos
	\land 128 repl_	str.c	memcpy(pret, to, tole
	🛆 132 repl_	str.c	memcpy(pret, pstr, cp
	🛕 145 array	_list.c	memcpy(index_ptr, da
	🛕 159 array	_list.c	memcpy(index_ptr, da
	🛕 159 char_	array.c	int size = vsnprintf(cha
	🔥 170 solit.		snorintf(string_arrav->
	INFO ANALYSIS STEP	s 🕕 🛛 stacks 🕕	
		Ŭ Ŭ	
	memcpy(pret, pstr, c ^	oylen);	
	Rule Id	clang-analyzer-securit	y.insecure API. Deprecated Or Unsafe
	Rule Name		
	Rule Description		cpy' is insecure as it does not provid us functions that support length arg C11
	Level	warning	
	Kind	review	
	Baseline State	new	
	Locations	repl_str.c	
	Log	clang_tidy.sarif	
-			

Cobra (code browser and analyzer)

An extensible, interactive tool for the analysis of C/C++ code

spaceros-user@ba0b59ced39b:~\$ ament cobra --help usage: ament cobra [-h] [--include dirs [INCLUDE DIRS [INCLUDE DIRS ...]]] [--exclude [EXCLUDE [EXCLUDE ...]]] [--ruleset RULESET] [--compile cmds COMPILE CMDS] --xunit-file XUNIT FILE] [--sarif-file SARIF FILE] [--cobra-version] [--verbose] [paths [paths ...]] Analyze source code using the cobra static analyzer. positional arguments: Files and/or directories to be checked. Directories are searched recursively for files ending in one of '.c', '.cc', '.cpp', '.cxx'. paths (default: ['.']) optional arguments: -h. --help show this help message and exit --include dirs [INCLUDE DIRS [INCLUDE DIRS ...]] Include directories for C/C++ files being checked. Each directory is passed to cobra as '-I<include dir>' (default: None) --exclude [EXCLUDE [EXCLUDE ...]] Exclude C/C++ files from being checked. (default: []) --ruleset RULESET The cobra rule set to use to analyze the code: basic, cwe, p10, jpl, misra2012, C++/autosar. (default: basic) --compile cmds COMPILE CMDS The compile commands. json file from which to gather preprocessor directives. This option will take precedence over the --include dirs options and any directories specified using --include dirs will be ignored. Instead, ament cobra will gather all preprocessor options from the compile commands.json file. (default: None) --xunit-file XUNIT FILE Generate a xunit compliant XML file (default: None) --sarif-file SARIF_FILE Generate a SARIF file (default: None) --cobra-version Get the cobra version, print it, and then exit (default: False) --verbose Display verbose output (default: False) spaceros-user@ba0b59ced39b:~\$

Process compliance

| NODIS Library | Program Formulation(7000s) | Search |



NPR 7150.2D Effective Date: March 08, 2022 Expiration Date: March 08, 2027

COMPLIANCE IS MANDATORY FOR NASA EMPLOYEES

Subject: NASA Software Engineering Requirements

Responsible Office: Office of the Chief Engineer

View all pages in PDF

Table of Contents

Preface

P1 Purpose P2 Applicability P3 Authority P4 Applicable Documents and Forms P5 Measurement/Verification P6 Cancellation

Chapter 1. Introduction

1.1 Overview 1.2 Hierarchy of NASA Software-Related Engineering and Program/Project Documents 1.3 Document Structure

Chapter 2. Roles, Responsibilities, and Principles Related to Tailoring of the Requirements

2.1 Roles and Responsibilities 2.2 Principles Related to Tailoring of the Requirements

Chapter 3. Software Management Requirements

3.1 Software Life Cycle Planning
 3.2 Software Cost Estimation
 3.3 Software Schedules
 3.4 Software Training
 3.5 Software Classification Assessments
 3.6 Software Assurance and Software Independent Verification & Validation
 3.7 Safety-Critical Software
 3.8 Automatic Generation of Software Source Code
 3.9 Software Development Processes and Practices
 3.10 Software Reuse
 3.11 Software Bi-Directional Traceability

Chapter 4. Software Engineering (Life Cycle) Requirements

4.1 Software Requirements 4.2 Software Architecture 4.3 Software Design 4.4 Software Implementation 4.5 Software Testing 4.6 Software Operations. Maintenance. and Retirement

Chapter 5. Supporting Software Life Cycle Requirements

5.1 Software Configuration Management 5.2 Software Risk Management 5.3 Software Peer Reviews/Inspections 5.4 Software Measurements 5.5 Software Non-conformance or Defect Management

Chapter 6. Recommended Software Documentation Contents

6.1 Software Engineering Products 6.2 Software Engineering Product Content

Appendix A. Definitions Appendix B. Acronyms Appendix C. Requirements Mapping Matrix Appendix D. Software Classifications Appendix E. References

List of Figures

Figure 1. NASA Software Classification Structure

List of Tables

Table 1. Bi-directional traceability by software classification Table 2. Requirements Mapping Matrix

DISTRIBUTION: NODIS

This document does not bind the public, except as authorized by law or as incorporated into a contract. This document is uncontrolled when printed. Check the NASA Online Directives Information System (NODIS) Library to verify that this is the correct version before use: https://nodis3.gsfc.nasa.gov.



NPR 7150

_	_	Make 2 Kingdo ann an	Sugar a St	-	_		_	-		_	-	
	7	Transmitter Transmitter	1	h	ŀ	ŀ	٠	ŀ		200	4	ŀ
**		Automa Response Proprietario		Γ		ľ		ľ				ľ
**		Education Cycle Pressing		Π	Γ	Г	Γ	Ľ				I
***	-	The popul manage that assess optimes to taken assesses	(min	1	۴	F	۴	F		-		ſ
113	-	Terpipi nange	Center		-	h	-	h	t	-	1	t
		and non-site substant plans, including security		L				L				l
		plant, ballouse the entire sufficient The space and on a minimum.		L				L				l
		alting for explorately of the damker with		L				L				l
114	-	Ter print manager	Cantan	h	÷	h		H	t	-	1	ł
		Party of printing of		L				L				l
		para alian alian ar		L				L				l
		talen, musiki, asi mangelik dinum h Chengelik		L				L				l
		constituents in a collector pines, that have been append to be for		L				L				l
		effected groups and behaviour are labor.		L				L				l
118	64	Terrariani memory	Center	R		F		h		00		t
		decoration accepterate attention for advant		L				L				l
***		The proper name	Cardon	h	F	F	•	h	t	1.00	1	t
		parties for selecter parties, selecter		L				L				l
		al destigation bases policit, deloration		L				L				l
		talear polarest		L				L				l
		property advantages development, and and the for advantages of \$10.000		L				L				l
		equilation of the framework operations of the state of th		U	Ľ		1	Ľ		1		ſ
14.7	-	Advantation The project manager	fantes	H	-	ŀ	÷	H	ł	-	-	ŀ
	Ľ	that define and document for interiorem of which for sufficient		U				l				I
		and on the second second		U	Ľ		1	Ľ		1		ſ
118	-	Terraini nange	Crear	h	-	þ	F	h	f	00	1	t
		Designation in address		U	Ľ		1	Ľ		1		ſ
		school prologramit		L				L				l
		distant), for sifteen distant() of he report hadro for		L				L				l
		school assess		L				L				l
		a Marine paded Integration		L				L				l
		perilitation administra la resulte administra di di Terrate della citatione		L				L				l
		and mater data. If Audi the scheme		L				L				l
		Patripation A		L				L				l
	L	inclusi and inclused standarge controps		μ	L	Ļ	L	Ļ			_	Ļ
	1	that anyon har selected shad anyon har selected shadowidd is provide	Canton	ľ	ľ		1	L		°		ľ
		posturite transmitty software charge tracking		L				L				l
		characterization in concertainment on a concertainment of a		L				L				l
		including sufficient dischapment and transported metrics		L				L		L .		l
1130	80	Teranipel manager that mappe for software	Creter	R	×	F		F		00		t
		deschards) is provide build with descent		L				L				l
		and destroyed to be property a condition		L				L				l
15.00	-	The proper memory and the	Cantan	F	F	F	•	F		-	1	t
		SPIT Rel at radial		L				L				l
		E consident and data follower construction		L	L			L				L
11.0	-	Silver appoint its popul range shall	Creater	1	*	F	*	F		00		F
				L				L				l
		designed, register, and		L				L				l
\square		Appress of the affected underset		Ц	L	Ļ	Ц	L	l	1	_	L
		and populations with software composition and	Canton	ľ	ľ		1	ľ		⁰⁰		ľ
		Company Color & Company Color & Color Data		U	Ľ		1	Ľ		1		ſ
		Appendix Applications in Sec. 1979, million		U	Ľ		U	Ľ		1		ſ
		Root Stripping and a strip patient of accomplicities		U	Ľ		1	Ľ		1		ſ
-		Space And Agencies.	Cantar	ŀ	Ļ	ŀ	Ļ	ŀ	ļ			ŀ
	Γ	that satisfy the Minutes conditions		ľ	Ľ		ľ	l		Ľ		ľ
		MOTO COLO, account in		U	Ľ		U	Ľ		1		ſ
		a. We require the later define the units of the		U	Ľ		1	Ľ		1		ſ
		b. Tor solvant component includes		U	L			l				l
		in introduct to fully in introduct parameters in a surger instructions)		U	Ľ		1	Ľ		1		ſ
		1. Propieting rights. Income tights, successfully, Income to Science of		1	L			L		1		l
		Agen, tambe agen, and condition of our (Fig.		U	Ľ		1	Ľ		1		ſ
		Aufter, and applicable former rations, adding		U	L			l				l
		supervised in the lateral state		U	Ľ		U	Ľ		1		ſ
		Lane Longe (r.g. Old.) (PL on 3 Longe)		U	Ľ		U	Ľ		1		ſ
		and contracts of Creation and contracts		U	Ľ		1	Ľ		1		ſ
		Property Council. 6. Pattern support for the sufficient postation		U	Ľ		1	Ľ		1		ſ
		present and adresses for propert ands.		U	Ľ		U	Ľ		1		ſ
		and others to be		U	Ľ		1	Ľ		1		ſ
		Analysis and a		U	L			l				l
		comparent for its intended aut. 1. The paper line again		U	Ľ		1	Ľ		1		ſ
		to particular particular decomposition of consider measured defends in		U	Ľ		1	Ľ		1		ſ
1		mage for defects, its set traped for original		U	Ľ		U	Ľ		1		ſ
					-		-		8			

10.0	-								
		"Links without the	1.00	F	Ŧ	R		r	
		and if the support for	· ·	r		Ľ	1		
		rights deared, and		L		L	H		
	1	A Territory and the	1	Ľ		Ľ	Ľ	L	
	1	cost parameters for all	1	Ľ		U	Ľ	Ľ	
	1	contit and it softwares	1	Ľ		U	Ľ	Ľ	
	1	And and a state of the	1	Ľ		U	Ľ	Ľ	
	1	a Geratiaer ani	1	Ľ		U	Ľ	Ľ	
		stands raid and		L		L	H		
		second states of the second states		L		L	H		
	1	signal References	1	Ľ		U	Ľ	Ľ	
	1	In the Posts	1	Ľ		U	Ľ	Ľ	
	1	A first school and	1	Ľ		U	Ľ	Ľ	
	1	successive and	1	Ľ		U	Ľ	Ľ	
	1	I and Ches 2 advant	1	Ľ		Ľ	Ľ	L	
		A lot about and		L		L	H		
	1	winter raid and	1	Ľ		U	Ľ	Ľ	
	1	considering (New of Ches.	1	Ľ		U	Ľ	Ľ	
_	<u> </u>	" when popula	<u> </u>	L	1	н	Ц	L	
-12	г×.	The print number is	Press (r	Ľ	rii	r)	Ľ	
		and using the		L		L			
		a Carnite star		L		L			
		to be located are articulard		L		L			
		and the second se		L		L			
		successive of the same		L		L			
		Including complexity.		L		L	H		
		Contract on the local division in which the local division in the	1	Ľ		U.	U.	Ľ	
	1	statute submitted	1	Ľ		Ľ	Ľ	L	
		replaced as he cost	1	Ľ		U.	U.	Ľ	
	1	salaring is to and	1	Ľ		U	Ľ	Ľ	
	1	relation of the	1	Ľ		Ľ	Ľ	L	
		d Income and Address	1	Ľ		U.	U.	Ľ	
	1	and one of solver	1	Ľ		Ľ	Ľ	L	
	1	successive for	1	Ľ		Ľ	Ľ	L	
	1	A location for some of	1	Ľ		Ľ	Ľ	L	
		for regime whener	1	Ľ		r i	I I	Ľ	
		Includes also donal	1	Ľ		r i	I I	Ľ	
-	-	the second second	-	b	÷	H	H	H	
11 A	Ľ.	and sheet shares	E	Ľ	Ľ	r1	r I	Ľ	
		other south a	1	Ľ		U.	U.	Ľ	
	1	survey, spinster,	1	Ľ		U	Ľ	Ľ	
	1	the Carlot resources in	1	Ľ		Ľ	Ľ	L	
		opposite of the	1	Ľ		r i	I I	Ľ	
_	-	tanian.	-	H	H	H	H	H	
43	-	Louise Linkins	-	H	-	μ	μ	L	
***	1	the property manager	1.000	ŀ	ŀ	P	r.	Ľ	
	1	California a sufficient	1	Ľ		U	Ľ	Ľ	
		the lateral growth sea	1	Ľ		r i	I I	Ľ	
	1	sound paper allocate	1	Ľ		Ľ	Ľ	L	
	1	structure of	1	Ľ		Ľ	Ľ	L	
		statement and	1	Ľ		U.	U.	Ľ	
	1	where below	1	Ľ		U	Ľ	Ľ	
	1	of the sprine.	1	Ľ		Ľ	Ľ	L	
	1	A Patrice Security of August Security of Security Securit	1	Ľ		U	Ľ	Ľ	
	1	where excipted	1	Ľ		Ľ	Ľ	L	
			1	Ľ		U	Ľ	Ľ	
				Ľ		Ľ	H		
		streets to any other states							
		Accessible for Approximation with other physical analysis are an approximation of		Ľ		U	U		
	L	erinette for Approximate auto ator aripeta anticente arapeta dependencies		ŀ	-	H	H	Ļ	
353.9	-	economic for approximation and radio original analysis original dependencies original dependencies for property terms of a represent terms of a represent terms	Casta	ŀ	×	ŀ	Η	ŀ	
35.9	-	econity for approximation with other pripely and inter- erupted dependencies. The applied memory and registery total actions of conformations.	Casta		×	1	h	ŀ	
532	~	Accessity for Approximations with adar approximations are proper dependencies. The project remaps of all expensity test access of underson closes of underson	Carlas		*	1	h	ŀ	
112	~	Accession for Approximation of a state approximation of a state app			*	•	H		
552	•	accelle for dependences une aller appende autoritation appendences appendences and appendences and appendences and appendences address and accesses and accesses and accesses and accesses and accesses and accesses and accesses accesses address accesses and accesses acc	Casta	*	*	•			
53.5	~	seconds to approximate set along approximate and approximate approximate approximate approximate approximate and approximate approx	Cardan	*	*	1			
113	-	seconds to approximate a scheduler popular and popularization popular appendiencies des popularizations control of scheduler control of scheduler control of scheduler control of scheduler and control of scheduler scheduler activities, scheduler activities, schedu	Contra Contra	*	*				
112		workets to appendiscusse and adre popular and accurate appendiscusse. The paperal scenage and appendiscusse and appendiscusses and appendiscusses	(see	*	*	*			
113	-	nemetri tri dependension sin aller popiti Antiones angere dependension. The argunt research dali approximities relation al relation dali approximities relation al relation relation and antionestication relation and antionestication dali approximities relation and antionestication dali approximities relationestication dali approximities relationestication dali approximities relationestication relationestication relationesticationestication relationestication relationesticationesticationestication relationesticati	(and the second	*	*		•		
	-	nemetri 10 dependencia sel della popola della sel casa apper di popola di sengeri della segnari di popola di sengeri della spato temperatori temperatori della sel casa consiste antonene della sel senancia sendano della spatori to solare senancia senandati temper to solare addende senanciali se popol della spatori to solare addende senanciali senangi della spatori to solare addende senangi constructori senangi constructori co	(www.	*	*		•		
113	-	nemetri to i depretationes and adre appendie depretationes and appendie depretationes appendie depretationes del respects y total sociale a studiante contract and studiante contract and studiante contract and studiante results and la propert results an	(www.	*	*	*	•		
332 344 344	-	Neverthe No. 19 Approximation and additional approximation and additional approximation approximation and approximation approxi	(*	•		•		
33.7 34.4 34.4	50 50	nemetrin to ' dependencina, sin date plipts and service plipts and service interpret dependencina interpret dependencina interpret dependencina desaurations of solutions control of solutions of data particular desaurations of solutions and solutions of solutions of data part anomali- data plant anomali- d		*	*		•		
313 314 314	50 50	nemetrin to the dependences, and addee applies the anti-ance applies the anti-ance applies the anti-ance applies and anti- tage and anti-ance applies and anti- antices, and applies and applies and the appliest anti- antices and appliest and appliest anti- antices and appliest and appliest appli	-	*	*	•			
113 444 34	10 10	nemetrin to i dependencies, sin data program constraints, sin data anticestational program anticestational program anticestational program anticestational program anticestation pro	Conte Conte Conte	•	•	*			
313 314 314 314 314	-	Hermiter for the second	(•	•	*	•		
337 344 344 84	50 54	neuron S Appendix and a set of Appendix and a set of appendix and a set of appendix ap		*	*	*	•		
33.0 44.4 34 34 34 34	50 50 50	neuron V Addata and a second and a second and a second and a second and a second and a def a spart compar- ded a spart compar- ded a spart compar- ded a spart compar- ded a spart compar- tion of the second and a second and a se	2000 2000 2000	*	*	*			
332 444 34 34	1	 Instruction is a second second	Cone Cone Cone	*	*	*	•		
53.7 53.8 54.4 54.4 53.2	-	numers in dependent of the second sec	Com Com Com	*	*	*			
552 555 555 555 555	0 0 0	neuron un de la construcción parte de la construcción parte de la construcción de la cons	Com Com Com	*	*	*	•		
23.7 24.4 24.4 24.5 24.5	a a	Amount of the second se	2000 2000 2000		*	*	•		
332 444 34 34 34 34 34 34 34 34 34 34 34 34	0 0 0	Amount of the second se	0.000 0.000 0.000	*	*	-	•		
33.7 44.8 34.4 34.4 34.4 34.5 34.5	0 0 0	 Anton M. M.		3	*	-	•	7	
33.2 34.4 34.4 34.4 34.2 34.2	14 14	Amount of the second se	Cone Cone Cone	2	*	-	•	,	
33.0 84.4 94.7 94.7	14 14	Amount of the second se	0 mm	3	*	-	•	1	
33.7 44.4 34 94 94.7	14 14 14		0.000 0.000 0.000	2	*	-	•	1	
23.0 24.0 24.0 24.0 24.0 24.0 24.0	-	Animation of the second	Cone Cone Cone	3	*	-	•	2	
23.2 24.4 24.4 24.4 24.5 24.7	10 10 10		Cone Cone Cone	3		-	•	-	
23.7 8.8.8 8.8 8.8 9.8 9.8 9.8 9.8 9.8 9.8 9	-		2 mm	3		-	-	3	
23.0 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4	10 10 10			3		*	-	2	
23.7 44.4 24 24 24 24 24	8	 Anterior and a second se	0.000 0.000 0.000 0.000	2	*	*	-	2	
332 34 34 34 34 34 34 34 34 34 34 34	100 100 100		2 mm	3	*	*	-	2	
2.5.7 2.4.4 2.4. 2.4 2.4 2.4 2.4 2.4 2.4 2.4	10 10 10			3	*	-	-		
33.0 44.4 54.4 33.0 33.0 33.0 34.4 34.4	14 14			2	*	*	-	2	
33.2 44.4 34 34 34 34 34 34 34 34 34 34 34 34 34	10 10 10		2 mm	3		*	-	2	
33.2 44.8 34 34 34 34 34 34 34 34	14			3		-	-	1	
33.7 34.4 34.4 33.5 33.5 34.7 34.4 34.4 34.4	-			3	*	-	-	2	
33.7 34.6 34.6 34.6 34.7 34.7 34.7 34.7 34.7			2 mm	3	2 2 2 2	-		-	
24.2 24.2 24.2 24.2 24.2 24.2			Com Com Com Com Com	3		*	-	3	
24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0	10 10 10 10		2 mm	3	*	-	-	2	
23.7 4.4.4 2.4 2.4 2.4 2.4 2.4 2.4 2		Annue and a second seco	2 mm	3		-	-	2	
23.7 34.8 34.0 35.7 35.7 34.2 34.2			2 mm	3	*	*	-	2	
23.7 24.4 24 24 24 24 24 24 24 24 24 2	10 10 10 10		Com Com Com Com	3	*	-	-	3	
2.5.7 2.5.8 2.5.4 2.5.7			Come Come Come Come Come	3	-	-	-		
227 24 24 24 24 24 24 24			7.000 7.000 7.000 7.000	3	-	-	-		
2.5.7 2.5.8 2.5.4 2.5.7	50 50 50 50 50		Com Com Com Com Com Com Com	3	-	-	-	3	
3.5.5 5.6.5 3.6.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5			Come Name Come Come	3	-	•	*	3	
33.0 34.0				3	*	* *			
3.5.0 5.6.0 5.6.0 2.6.0 2.6.0 2.6.0			Come Name Come Come	3	*	-	-		
33.0 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4				2	-	-		-	
31.5 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6				2	8 8 8 8 8 8	-	-	-	
33.0 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4				2	8 8 8 8 8 8	-	-		
33.5 34 34 35.5 35.5 35.5 35.5 35.5 35.5				3	* * * *	-			
357 344 34 357 357 357 357 357 357 357 357 357 357	00 00 00 00 00 00 00 00 00 00 00 00 00		Com Com Com Com	2	* * *	-			
3.8.7 3.8.8 3.8.9 3.8.8 3.8.9				3					
557 244 244 245 245 245 245 245 245				3					
22. 24. 24. 24. 24. 24. 24. 24. 24. 24.				3	*				
23.0 24.0				2	-				
11.7 11.7 12.7 13.7 13.7 14.7				3					
33.7 34.4				2 3 3 3 3 3					
337 34 34 34 34 34 34 34 34 34 34 34 34 34				3		-			
33.5 34.6 35.7 31.7 31.7 31.7 31.7 31.7 31.7 31.7 31						-			
14.4 1 14.4 14.4 1 14.4 1 1									
1327 134 14 14 1327 1327 1327 1327 1327 1327 1327 1327				2 2 2 2 2 2					
33.7 4.4 44 4 52 5 53.7 5 53.7 5 53.7 5 53.7 5 53.7 5 53.7 5 53.7 5 53.7 5 53.7 5 53.7 5 53.7 5 53.7 5 53.7 5									

			_	-	_		_		-		
333	-	In paper names, in	Creater	ľ	×	ľ	ř	ľ			
		tisk separation, shall drive and		H				Ш			
		considered in the safety-		H				Ш			
		ontional per liter unitation		H				Ш			
		8738.A		Ш		Ш		Ш			L
372	63	Experience salely	Crear		×		×	П			Г
		propert manager what		H				Ш			
		other allows		H				Ш			
		+ MARA UTD STREET		H				Ш			
17.0	114	Experiences safely	Center	h	х	h	×	п			r
		entrol televant or retrology utilized televant						Ш			
		for paint except that						Ш			
		inter in the unitarian		H				Ш			
		estimationed, as first when						Ш			
		and implain, to a known						Ш			
		6. The software safety						Ш			
		problem linear sides.						Ш			
		to solve an invited in						Ш			
		sale state.						Ш			
		4 Operator sometime of						Ш			
		equips at load loss						Ш			
		er opension						Ш			
		community musicant and						Ш			
		d'unpasse alles		H				Ш			
		community and of						Ш			
		turni.						Ш			
		coduction convery						Ш			
		many is a brane rate						Ш			
		to The solicite perform						Ш			
		stimptly checks on		U	H		L	U			
		Advention adventory of the second	L 1	U	Ľ		Ľ	U			
		1. To school print	L 1	U	Ľ		Ľ	U			
		to the remains of	L 1	U	Ľ		Ľ	U			
		comparish.	L	I I			Ľ	I I			
		want or miles is	L	I I			Ľ	I I			
		disend is initial as similar based	L 1	U	Ľ		Ľ	U			
		The sufficient respects	L 1	U	Ľ		Ľ	U			
		condition within the low		U	H		L	U			
		Incodes and	L 1	U	Ľ		Ľ	U			
		rear handling.	L 1	U	Ľ		Ľ	U			
		for update lide a sale		U	H		L	U			
		cain.		Ц		Ц	L	Ц			L
87.4	110	Company in a safety	Center	H	×	M	×	Ш			
		project example what						Ш			
		percent cash lend		U	H		L	U			
		Station .	L 1	U	Ľ		Ľ	U			
		Comp (CCC)	L 1	U	Ľ		Ľ	U			
		otestas for all identified tably united to beam	L 1	U	Ľ		Ľ	U			
_		corporatio.		Ц		Ц	L	Ц	Ļ		Ļ
					х		×	Ш			
		pripti surange chall						Ш			
		ottical software, the project example shall ensure all stretched solidy utilized software						H			
		official software, for project manager chall measure all strengther software all strengther comparation from a contaments. State a contaments. State a						l			
		otical solucan, ke popul namage chail ensue al' ciettine catero cietti ciettine comparato hare a contanto complexity otice al ili a base for mumber dall te									
		othical solitoute, Eur project rearranges chall ensure at all solitotheal solity utilical solitoner components, have a cycloaratic somephonig solitor of 20 or bases, how manufacture shall be encirculated and solitoti with anisotability the									
	-	othiod software, for project compare shall indust all identifiest indust patient subscript comparents incomplexity other all its income from encinement and southers maintenance shall be maintenance and southers properties and project subscript properties and project subscript properties and project subscript and and and and project subscript and									
		which colours, for payor i rearger shall encour all site shall always which such as a supported bases of a supported bases of a support of the same Any mombal and all the mombal and and which add agened address?									
14		which colours, the paper i reargers shall many attraction soliday selection interna- colours attractions applied and the solid law moment and these Aray momentations shall be minimum and automation with salamatic by the solidaria displayment automatic approval automatic approval	Labore 1		-0						
14	-	elitical colourant, the people's reasonances was all climitical course and climitical comparents. Issues a co- comparation comparing order of this taxons from momenta and mactional people and and and moment and maction and marks that and addressing and addressing and addressing and the second and and and the second and and and the second and address and addressing and addressing and addressing and addressing and address and address and the second addressing and addressing addressing and addressing add	Labore D		×					00	ľ
14	-	edition columns, the propost assumption manual and advecting compared to the set compared to the set compared to the set compared to the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the encodered of the set of the set of the set of the set of the encodered of the set of the set of the set of the set of the encodered of the set of the set of the set of the set of the encodered of the set of th	lahar + li Coix		×					00	
14	-	netted selections for people resurger shall mean all classified and present all classified compared to the selection compared to the selection of the selection of the selection of the selection of the selection with advanced agenced advanced agenced advanced advanced agenced advanced agenced ad	Liber + D Contr		*	-				60	
14	-	nition destants, les engent ensagers dest engant auf diestfahl engen auf diestfahl engeneembe here an engeneembe here a engeneembe here a engeneembe here an engenten destants diest engent einer die die die engent ensager ein engent ensager ein herheiten die einer diest aufdertijf, generatien die einer die generatien die einer die einer die einer die einer die generatien die einer die einer die einer die einer die here die einer die einer die einer die einer die einer die generatien einer die website die einer die einer die einer die einer die einer die einer die einer die einer die einer die einer die einer die einer die einer die einer die einer die einer die einer die einer die einer d	Coase		*0					640	
14	-	nition forknome, her segment of searching of the second of the second of the second order of the second of the exploration completely and exploration completely and exploration to get the momentation of the these second order of the test tests. For momentation to get the momentation to get the exploration to get the exploration of the second addressing of the second addressing and the second parameters of the second of the addressing activities of the second parameters of the share and the second of t	Labore D		*					640	
24	14	nitial selacas, ter espejat secargar dell escarga di discilitati escarga di discilitati escargaretti hare a sphanisti semptori patto di discilitati andi discilitati esti discilitati di discilitati esti di discilitati più esti di discilitati più esti di discilitati di discilitati esti di discilitati espejanti la discilitati di discilitati esti esti esti di discilitati di discilitati espejanti la discilitati discilitati esti esti esti di discilitati di discilitati di discilitati esti esti esti esta dalla generationi esti esta dalla generationi esti esta escargaretti di discilitati escargaretti di discilitati	Tabar + D		*0					00	
24	54	nition of solutions, the opposed energy what and a solution of the solution of the solution of the solution of the solution of the solution of the solution solution of the solution of the solution solution of the solution of the solution solution of the solution of the solution of the solution solution of the solution of the solution of the solution solution of the solution of the solution of the solution solution of the solution of the solution of the solution solution of the solution of	Editor + D Entire		*0	*				00	
24	3	netted settemen ber appel er energier viell energier er einer versieht of energier energier einer have an exchange of the basis of the moment of a standard moment of a standard moment of a standard moment of a standard propel a standard of the standard by the propel a standard of the standard by the applier integrate of the standard of the adverse of the standard of the appendix standard of the and the total and the advector of the standard and the advector of the advector of the standard and the advector of the advector of the standard advector of the advector of the standard advector of the advector of the advector of the standard advector of the advector of the advector of the standard advector of the advector of the advector of the standard advector of the advector of the advector of the standard advector of the advector of the advector of the advector of the standard advector of the advector of the advector of the standard advector of the advector of the advector of the advector of the standard advector of the advector of the advector of the advector of the advector of the standard advector of the advector of the advector of the advector of the advector of the standard advector of the advector of t	Endow + D Conter		*					00	
38	34	Initial selection, bei prinst memory bein entry visited unformer entry visited unformer and the selection of the selection of the selection of the selection of the selection of the selection of the selection of the selection of the selection of the selection of the selection of the selection of the selection of the selection of the selection of	Enter + E		*					00	
38	14	nitrid statems, be replyed analysis of the second output with a subset of the second output with a subset of the second output statement output statement of the second output statement of the second output statement of the second output statement output statement of the second output statement output statement of the second output statement output statement output statement of the second output statement output statement output statement output statement output statement outp	Enter + E		*0					00	
24	14	nini dia kan bi perini kanga dari dalam kan bi kan	Talaar + D Data	*	*					00	
24	38	mining damage the second secon	Eduare b		•					00	
28	34	andred Anton Teir and Anton Teir Anton Tei	Talaa + E Caas		*0	*				00	
24	14	and of other the other than the other and other the other than the	Eduar E Com	*	*					60	
14	18	nind data ta'i ang a sa ang a	Eduar + L Ease	*	*					66	
18	-	and of dense to be a second and a second and a second and a second a second and a second and a second a second a second a second and a second and a second a seco	Enters + Er		*					60	
18	-	 Andre de la construcción de la constru	Talace to Design		*					60	
28		nich den an der her her her her her her her her her h	Eduar t L		*					60	
28		 Andre de la construcción de la constru	Const		*					68	
18		nich den generation for source at a standard source and a standard source source at a standard source source at a standard source source at a standard source at a standard to the source at a standard source at a standar	Color I		*	*				60	
28		 Andra dana tao tao tao tao tao tao tao tao tao ta	Ealers + E Eaner	*	×					00	
24		nicht often für die seine	Edina + E Com	*	*D		х			00	
38		 Andra dana tao tao tao tao tao tao tao tao tao ta	Eduare L Ensure		*D	*	x			00	
38	34	 Marka Alama Yao Marka Marka Marka Yao Maraka Marka Marka Yao Marka Marka Marka Marka Yao	Later + L Date	X	×D X	*	х			60	
1.8	346		Educe + E Emm		* Co 3	1	x			00	
24	10		Cone		+ Co X	2	х			00	
24			Edua + E Essa	*	*D	-	x	_		00	
38 383 183			Editor + E Come	1	X		X			00	
24 383 383 384 385			Entrare to		× Co		x			00	
18 18.1 18.2	306		Eduar + E Conse Eurose	-	× Co	-	×			00	
24 383 383			Edward D Emm		a Contraction of the second se		*	_		00	
2.8 3.8.3 3.8.3 3.8.3	206	 Alex Application Sector Sector	Eduar F L Deser Conser	x	8		*	_		00	
24 383 383	206		Com Com Com		x X		×			60	
24 383 383 28 28	2.0		Enner		x X		×			00	
248 188.3 188.3 188.3	24		Come		8	-				00	
2.8 2.8.3 2.8.3 2.8.3	2.8		Easer Easer Easer Easer Easer Easer Easer Easer Easer		8	2		_		200	
18.3 18.3 18.3	2.0		Eduard L Const Con		A N		*	_		60	
34 343 343 343 343	1.00 1.00		Extense + Extens		a Diala di Anglia di Angli		*	-		00	
24 38.5 28.2	205		Come	-	x X		*	_		00	

-	-	Colorer Cognering (a contra	*	-	•	-	-		-
	-		Castra	E	E.	Ŀ.		-	100	Ŀ.
	Ľ.,	shad minister, sugar,	1	Ľ	Ľ	ſ	j I	1	1	ſ
	L	ration officer		L	L	L		1		L
	L	delimination for COTS, CoLTS, MATHER, COLS, or		L	L	L		1		L
	L	compositio, or put of		L	L	L		1		L
	L	for included		L	L	L		1		L
	***	Ter propriet manager	Contra	F	F	F	П	Т		Г
	L	maximum materia		L	L	L		1		L
	L	and detected requirements.		L	L	L		1		L
	L	And in case of the local division of the loc		L	L	L		1		L
	L	which the product of the local state		L	L	L		1		L
	L	uport data and		L	L	L		1		L
64	21	Transact	Center	h	k	b	Н	÷	-	t
	I 1	shall include sufficient		L	L	L		1		L
	I 1	contents, collets,		L	L	L		1		L
	I 1	And address of the owner.		L	L	L		1		L
	I 1	and unlease in the		L	L	L		1		L
		And and a second second	Cashe	H	ŀ	ŀ	Н	-	-	÷
	F .	day had not recept		П	Г	Ľ		1	F .	Г
_		equipments.		L	L	L	Ц	1		L
614	-	International Property lies of the local division of the local div	Creater	۲	ř	ľ	*	1	⁰⁰	×
	L	tank off down		L	L	L		1		L
	L	representation of the second		L	L	L		1		L
		parts and advant		L	L	L		л		L
617	-	Second company	Creater	F	×	F		1	00	×
	1	Paperson address		Ľ	Ľ	Ľ		1	1	L
	1	where of prices as		Ľ	Ľ	Ľ		1	1	L
		Palaret.		L	L	Ĺ		1		L
-		Colour & La Mindare	_	2	1	2	_	-	_	_
	82	the property manager that benchmichter	Creater	P	F	P		Į.	1	E
	1	equipments for the		Ľ	Ľ	Ľ		1	1	L
_		offerer autoritati		L	L	L	Ц	4		L
42.4	P* 1	the party is not as	Creater	ľ	r	ľ		ſ	1.7	Ľ
	L	delibertunt string of		L	L	L		1		L
	1	A Company 3 Pageste	1	U	Ľ	Ľ	U	1	1	L
	1	fails.		Ľ	Ľ	Ľ		1	1	L
	1	A Calego J Papele A Briad a SPR	1	U	Ľ	Ľ	U	1	1	L
	L	A or Class. 8 paginal		L	L	L		1		L
_	L	OPH STAL		L	L	L	U	J	L.,	L
63		Entres - Design	_	2	2	2	1	1	_	
-		The property manager	Enter	F	F	F	П	Т		Г
	L	and real-later a variance		L	L	L		1		L
	L	offerer addressed		L	L	L		1		L
	L	from the state of the		L	L	L		1		L
_	_	coupled, and mind		L	L	L		1	_	L
44			_	_	_	_	_	_	_	_
44.7	-	that implement the	Contra	M	۲	ŀ		1	· • •	ľ
	L	software design into software code		L	L	L		1		L
643	111	Teaching	Creater	R	k	ħ		1	00	×
	L	alter's shear		L	L	L		1		L
		designed, and other		L	L	L		л		L
64.6	10	Teachings	Center	F	F	F	R	Т	00	×
	L	talk is and or for call		L	L	L		1		L
	L	estimating planets in al		L	L	L		1		L
	I 1	officia, sufficiant		L	L	L		1		L
		and software companyly		L	L	L	Ц	4		L
448		that and that the	Creater	r	r	P	1	1	P**	ľ
-	-	uniquer cole		μ	L	┡	Н	4	-	₽
- **	Ľ.	chall arrays that he will		Ľ	Ľ	ľ	r I	1	E	r
		eposiale.		L	L	L	Ш	Т		L
447	-	The property strength of the local division of the local divisiono	Creater	F	F	F	P	Ţ	00	F
	1	senior description for tank sufficient minutes	1	U	Ľ	Ľ	U	1	1	L
	-	Te provincement	Cantor	h	t	t	Н	÷	-	t
	Ľ.,	that satisfies and	1	Ľ	Ľ	Ľ	U	1	1	L
	1	And a second sec		U	Ľ	Ľ		1	1	L
	-	offent	L	L	L	Ĺ		1		1
ud.	-	Concere Traing	_	-	-	-	_	-	_	-
***	1ª .	the proper manager	1.000	Ľ	Ľ	r	r I	1	1°°	r
	1	A Subserved plays)	1	U	Ľ	Ľ	U	1	1	L
	1	a subcarini pumbarjij		U	Ľ	Ľ		1	1	L
	1	n finderan tenipij techning any code	1	U	Ľ	Ľ	U	1	1	L
	1	prist in parties		Ľ	Ľ	Ľ		1	1	L
	-	A contrast the spatial	Canta	H	b	ŀ	Н	4	-	÷
	Ľ	that the late sufficient		D	Ľ	Ľ		Į.	Γ.	Ľ
-		The subscription of the	Contra 1	h	h	t	Н	4	100	t
	Ľ.	that place whereas		Ľ	Ľ	Ľ		1	1	ſ
	1	Compared places		Ľ	Ľ	Ľ		1	1	L
61.1	-	Terriptinenge	Center	h	k	Þ	Н	t	00	k
	1	main and musicing		U	Ľ	Ľ		1	1	L
	-	And and a second se	-	μ	H	L	Ц	4	-	1
-	P° Î	the property support	Center	P	r	P	11	1	1.1	Ľ
	1	Aumini udear taith, situiden, an		Ľ	Ľ	Ľ		1	1	L
	1	and put halo married to peter spatification of		U	Ľ	Ľ		1	1	L
	L	Topi schear a Topi record		U	L	Ĺ	U	J	L	L
	87	Te province age	Contra	F	F	F		1	00	×
48.7	1	reaction for sufficient		Ľ	Ľ	Ľ		1	1	L
48.7	1	to be completed with		Ľ	Ľ	Ľ		1	1	L
48.7	-	official implements	-	H	H	ŀ	Ц	4	-	⊢
48.7		dual and date for		ľ	ľ	ľ	U	1	1	L
61.7	°			U	Ľ	Ľ		1	1	L
a.,	" "	support platters a high-			-	۰	H	+	-	۰
	-	support products a high fabricy consistent. The control manager	Center							
-	24	Ingeneryisten a top Satty constatue Toronogic menage and constatue to	Crear	ſ	ľ	ľ				L
-	-	Segment pinton a tight fability constants. The population static consegn static consegn constants for the constants of the time	Crear	1	ŕ	ľ		I		L
-	24	implet picture a tapi bibliq condution. To point remain shall ensure that the rest ensurement of a commp measurement. To the solid-are are obtained, implemented, instant manifest inter-	Center	*	×	ľ		ļ		
-	-	superior proteine a trajé- bitity constation. The post-interaction control and the tra- cost exemute control and the tra- software are tolocited, implemented, taxinol excession, and equator. Theorem of the tra-	Ceder	*	ŕ	ļ		ļ		ļ
-		negator politics a high faithy establish. To paper inseage out a summary out a summary encoded and for encoded and episted interpret menage that only use	Coster	*	×			$\left \right $		┞

44.20 44.20 44.40	113	But obtain have not been include and into personally totageded ar anised software and have estimated and a security coloredging that under a security for under the security for under the security of under an anisotropy of the software as function that have to a baseding transf.	(min							
44.00 44.00 44.00	-	Anto compared or minist software and have and produced a sociality coloniality. The project compare what only founds held for software requirements find have to a facinities mont, canon a witiliation	Conten	L				1	1	
48.32 48.35 48.36	10	termany. To point comprised that with though but for unlease explorements that have to a harmonia mont, capes or unleader	Caster	ŀ						
44.38	10	shaft umlig forsigh test for software engineering fod hour to a harantean transf, Lange, or religation				H	Н	Н	-	ł
** 10	101	a facados nord, casos arreliados		Г						I
****	143			L						l
****		Ter project manager	Casta	F	×.	H	Н	Н	00	ħ
****		acceptance texts for basiled an apleticed data.		L						l
44	1	almis solean and silmis solean and		L						l
44	-	Interio Termini mener	Center	ŀ	Н		Н	Н	-	ł
		shall bed andwidted COTE, GOTE, MOTE,		L						l
44		components in the same		L						l
**		sufficient component for its intensited user.		L						l
		Eduar Operations, Management, and		Г	П	Π	П	Π		t
	-	Patiencesi Teranimi menen	inter .	ŀ	Н	Н	Н	Н		ł
	Ľ	shall plan and implement tellinant quantum,		Г					E .	Γ
		eterent adultes		L	Н	H	Ц	Ц	_	ł
	Ľ.,	shall complete and define the units and	-	ľ	ľ				Ľ.	ľ
		self-appropriate recently,		L						l
		secold, to upped the operations and		L						l
	-	for subset's lit spin.		Ļ	Ц	L	Ц	Ц	-	ļ
***	-	The project manager what complete prior to definery, conflication that	Contra	ľ	*				*	ľ
		all software requirements identifies for the definery		L						l
		dependented, that all approach changes have		L						l
		Dated drives and des		L						l
_		prio la dell'orginare beni orginali		L	Ц	Ц	Ц	Ц	_	Ļ
***	-	The project manager school materials for sufficiant period carebook	Conten	ľ	1				· ·	ľ
		and processors, per lise applicable underset		L						l
_		the maximum phone.		L	Ц	Ц	Ц	Ц	_	Ļ
	Ľ	that identify the recently and collected to be to be	Canton	ľ	ľ				Ľ.	ľ
		actions, for location of the authors, and		L						l
		for products for undersore princepal or despendi		L	Ш	L	U			L
		Reporting Radium v Lab	Cabrillog	•••		•	_	_		_
		Terpopul menge	(min	F	1	•	×	П	00	F
		configuration reasonagement plan that		L						l
		expendition, and automy to the		L						l
		Indexes and particular		L						l
		paper		L	Н	Ц	Ц	Н	-	ł
	_	chail hack and makater charges is software	_	ľ	1				Ľ.	ľ
114	-	Terpopul menager	Center	ŀ	×.	2	x	Н	60	ŧ
		chall identify for tailment configuration from (e.g., safecare		L						l
		bach, cold, bids, bach, readdh, unight; and fast unities to be		L					1	I
	-	conductor for propert.	Carlos .	ŀ	H		H	Н	-	ł
	Ĩ.	shall making and implement prantises to	_	ľ	Ľ			1	Ľ	ľ
		a conceptor for intella of control through which much identified sufficient		L						L
		configuration lines in empirical in passe.		L					1	I
		groups with authority in authority changes.		L						l
		 Modify the persons of groups to make changes at each local. 		L						l
134	-	Terunipal menager shall perpart and	Center	F	×	×	×	Π	00	Ē
		maintain much of the configuration claims of		L						l
	-	in a		ŀ	Ц	H	Ц	Ц	-	ļ
	Ľ	that perform sufficient configuration multiple		ľ	Ľ				Γ.	ľ
		contact of the contact contact of the software configuration through and		L					1	I
		unity that they unders to the seconds that define them		L					1	I
	-	The project messages	(min	F	h	1	F	H	00	f
		Inglement providiants for Devicement handling		L				1		L
		defining others and maintenance of definingin unforces		L						I
	10	prelach.	Center	ŀ	H		Н	Н	00	ł
1	Ľ	what past-spate is any		ľ					Ľ	ľ
62		Educe 17th Hanger	-		-					1
13	296	Labor - Rick Manager Visit munit, analyse, plan, back, control, and	Crete	f	*	×	Π	1	~	ľ
		companying of a lar		Ľ						

**		Concert raw Parates	-	-	-		_	-	-	-
133		the project manager shall perform and report	Creater	ľ	Ľ	ľ				00
		per mais a caluar		L						
		improtors for		L						
		implements.		L						
		is Enlarge plans,		L	L					
		 Any design terms that 		L						
		software pres mainte at		L						
		ecosity is the submar		L	L					
		development plans. 6. Enforcer under en		L						
		defined in the software		L	L					
		e. Eulleuar ini		L						
633	-	The pages i manager	Cester	×	х	х	F	h	h	
		sollaran pen mona ar		L	L					
		a this a sheaking or		L						
		hand make intripe		L	L					
		making to makate the		L	L					
		b Use middloled		L	L					
		completion coloria.		L						
		 Task mitten Method is the minute 		L	L					
		until dany are encolored.		L	L					
		pathipath.		L	L	Ш		L		
634	644	The proposi manager	Cester	×	×	x		г	n	610
		shall, for each placend software peer encine or		L	L					
		software improtion,		L						
		resumments.		L	L		L	L	L	
64 642		Enforce e Meanur en ante					_	-		_
6.4.3	-	The propert manager shall enablish, second,	Cester	ľ	ľ	M				
	1	exectain, ergod, and addies software	1	L	1					
	1	management and	1	1	L					
	-	strend resources	-	÷	H	Н	-	H	H	_
	- T	shall analyze softeners	C. Make	Ľ	Ľ	Ľ				
	1	consumer to the	1	1	Ľ					
	1	discussional property	1	L	1					
	1	Contentingenticational	1	1	Ľ					
_		enelysis procedures.		L	L	Ц	L	L	μ	_
	-	The propert manager	Croix	1×	K	N	17	Ľ		
	1	for solution	1	1	L					
	1	consumerated data, consumerated analyses,	1	L	1					
	1	and software development status as	1	L	1					
	1	expanded to the	1	1	Ľ					
	1	Combaste, Re MARA	1	1	L					
	1	Chief Engineer, Bar Contex 'M.s. 14) 3.MA.	1	1	Ľ					
	1	and other organizations on appropriate.	1	1	L					
8.4.8		The propert memory	Center	t	i.	H	F	h	f	_
	1	shall months resources		ſ	Ľ	E)				
	1	cult rand or record	1	L	1					
	1	furniturally	1	L	1					
	1	equiproveds, including satisfying combaties	1	L	1					
144	100	The section is supported	Cashe	t	t-	Н	H	h	f	-
	17	shall collect, back, and		ſ	Ľ					
	1	explorately solutily	1	L	1					
	-	Talana Manana	tere or Date			Ц	-	-	1	
	-	The second strength in a	Louis .	Ē	ñ	in a	-	Ē	п	00
	Ľ.	shall back and maintain		Ľ	Ľ	Ľ	1			
	1	contamenters (including	1	1	L					
	1	defects to body and appropriate ground	1	1	L					
		(chear)		Ļ	L	Ц	_	L	Ц	
6.6.2	262	The project manager shall define and	Crebe	×	×	[×]				00
	1	implement along sufficient	1	1	Ľ					
	1	sufficient rate	1	1	Ľ					
	1	kels, COTE, DOTE.	1	L	1					
	1	MOTE, CELE, mused	1	1	Ľ					
	1	and applicable general	1	1	L					
			-	Ł	H	Н	H	H	H	_
	Ľ .	shall implement		ſ	Ľ	r)				
	1	standatory accordinates	1	L	1					
	1	COTE COTE MOTE	1	1	Ľ					
	1	CILE, and/o mound unlease components	1	1	L					
114	204	The amount manager	Center	t	x	Н	H	H	H	_
	E .	shall implement process		ſ	Ľ					
	1	soundly sufficient run	1	1	Ľ					
		toop process)	1	L						
				.,						
		lace Chapters Chapters								
-11		laur Chupteri Chupteri Andre Appendici App Add Add	Chapters () (NU		4				
		land (Chapteri) (Chapteri) andrek (Appendiali) App ALL EDE Lähney Program Pare	ndato (10)							



NPR 7150

							_					
5.0		Supporting Software Life Cy	cle Requir	em	ent	s						
5.1		Software Configuration Man	nagement									
5.1.2	079	The project manager shall develop a software configuration management plan that describes the functions, responsibilities, and authority for the implementation of software configuration management for the project.	Center	×	×	X	X		CIO	X		
5.1.3	080	The project manager shall track and evaluate changes to software products.	Center	X	Х	Х	Х		CIO	X		
5.1.4	081	The project manager shall identify the software configuration items (e.g., software records, code, data, tools, models, scripts) and their versions to be controlled for the project.	Center	X	X	X	X		СЮ	×		



Traceability: CRs to Code

 tag...
 main
 remotes/origin/humble-29/23:10.0
 remotes/origin/main
 Merge pull

 Delete .github/workflows/vcs-repos.yaml (#88)
 Make vcs-repos Action job be manually-triggered (#88)
 Make vcs-repos Action job be manually-triggered (#88)

 Merge pull request #92 from ivapperez-keera/readme-fix-linkcontrib
 Fix link to contributing guide (#89)

 Commit from GitHub Actions (Generate vcstool repos file.)
 Merge pull request #87 from ivapperez-keera/readme-contrib-rules

 Link to contributing guide from README (#76)
 Document contribution rules (#76)



Process Compliance

- Process (DONE)
- Auditing via scripts, running in Cl (started)
- Auditing using reporting tools (ongoing, more later) (currently NASA only)



Current Status (Dec 2024)

- 5 releases published at regular intervals (quarterly releases)
- Next release planned for Jan 2025



Current focus (Dec 2024)

- Simplifying the development process.
- Support for other architectures.
- Documenting development, maintenance.
- Adding better integration of static analysis and V&V tools.
- Evaluating and facilitating compliance with NPR7150.2.
- Integrating demos from NASA Spark challenge.
- Increasing participation from the community.
- Working on integration with cFS and FPrime
 - Traclabs bridge.
 - JAXA bridge.



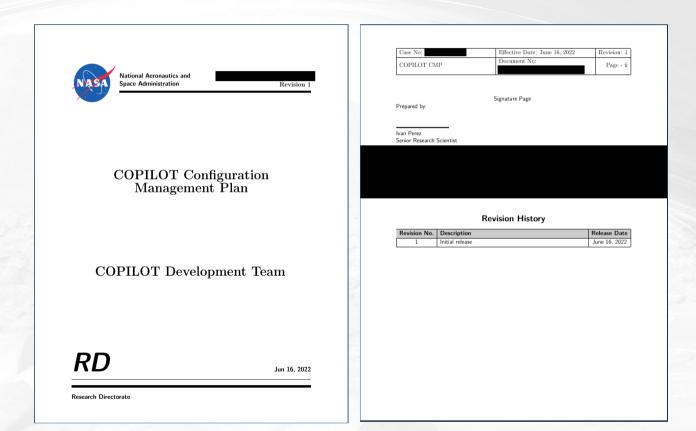
NASA/TM-XXXXXX



NPR7150.2 Compliance in Space ROS

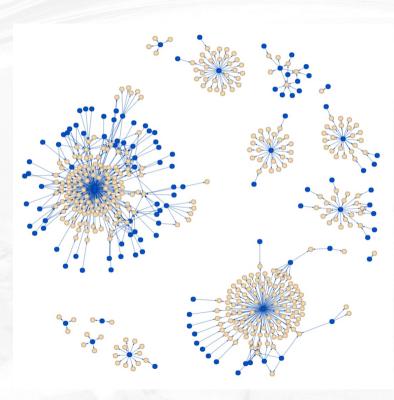


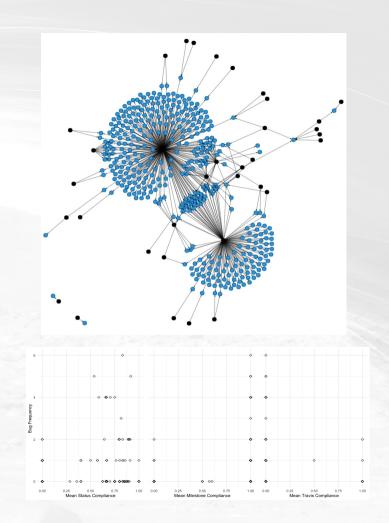
Documentation





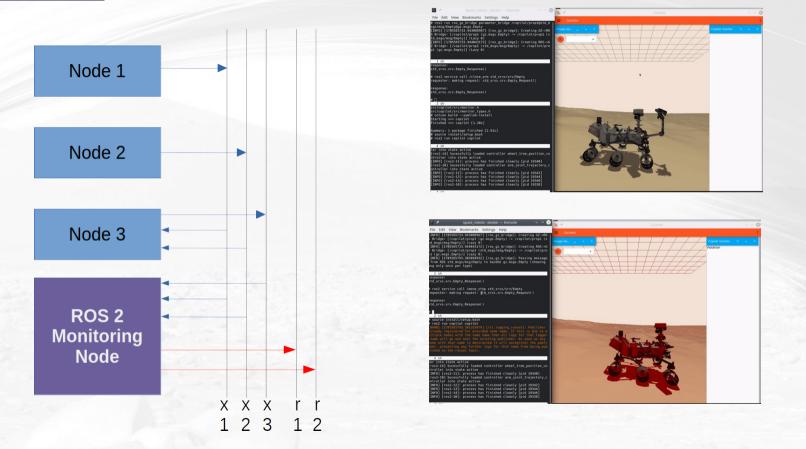
Automated Auditing







Runtime Monitoring of Space ROS with Copilot



https://github.com/Copilot-Language/copilot/



Lunar Command-and-Control Interoperability Project (LuCCI)

We use Space ROS to evaluate different bridges between cFS and ROS. We have multiple simulations using both the JAXA and Traclabs bridges.

We have communicated feedback on cFS-ROS bridges to upstream maintainers.

Will be seeking integration with Isaac SIM in FY25.

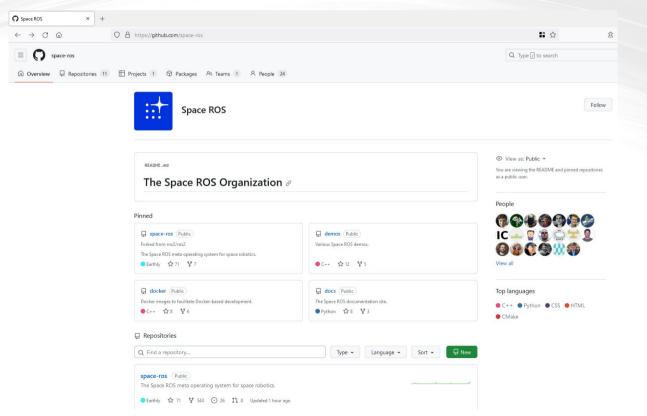
We have carried out a survey of flight and robotics software frameworks used in different missions (paper available), and we are conducting a trade study on communication mechanisms between flight and robotics software stacks (ongoing).



Our wish for Space Grade Linux

- Our deployment is a docker image based on docker, but Space ROS can be used on other Linux system.
- A docker image based on Space Grade Linux could be used as the base for future Space ROS images, immediately bringing a production-ready stack to Space Grade Linux with minimal effort.
- The same ideas, systems and techniques we use to make Space ROS systems safe could be used for Space Grade Linux, and systems based on Space Grade Linux.

Space ROS Github Organization https://github.com/space-ros





space**ROS**

Ivan Perez KBR @ NASA Ames Research Center ivan.perezdominguez@nasa.gov """

Thanks to:

Tommy Madsen, Matt Hansen, Michael Jeronimo, Brian Kempa, Blazej Fiderek, Ana Huaman, Dharini Dutia, Geoffrey Biggs, Ezra Brooks, Alexey Simonov, Dave Coleman, all past and present project partners, and everyone who has contributed!