

# USLP Standards Test Status

“Approved for Public Release; Distribution is Unlimited”

***Sponsoring Org/Office Code: HP27***

***Stakeholders: Rodney Grubbs***

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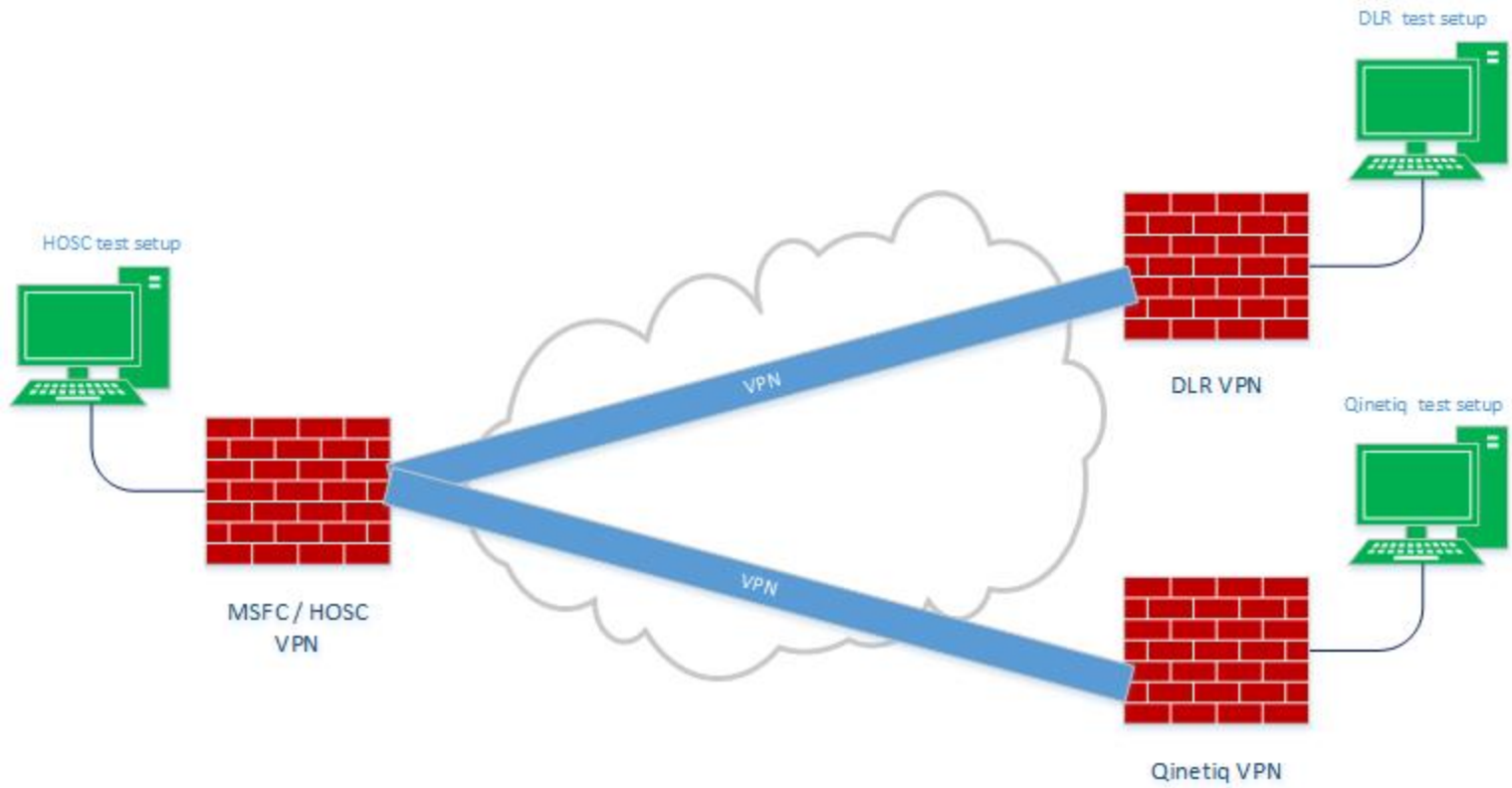
***Presenter Name***

Robert Lee Pitts



- Three implementations were developed and node locations for these tests are:
  - USLP implementation from NASA Marshall Space Flight Center
  - USLP implementation from DLR at German Aerospace Center.
  - USLP implementation for Qinetiq supporting UKSA.
- Implementations were conducted remotely over VPNs
- Each end was developing and testing incrementally
- Final testing was on Red-3

- Allows multiple tests with MSFC being the common element
  - Multiple independent tests with only minor participation of a secondary tester
  - Testing occurred between MSFC and DLR
  - Testing also occurred between MSFC and Qinetiq
  
- Secondary testing was accomplished by file exchange and processing offline
  - Large frames are fragmented by UDP and received out of order
  - Processing requires the insertion of “test artifacts” that simulate unique conditions; e.g induced errors

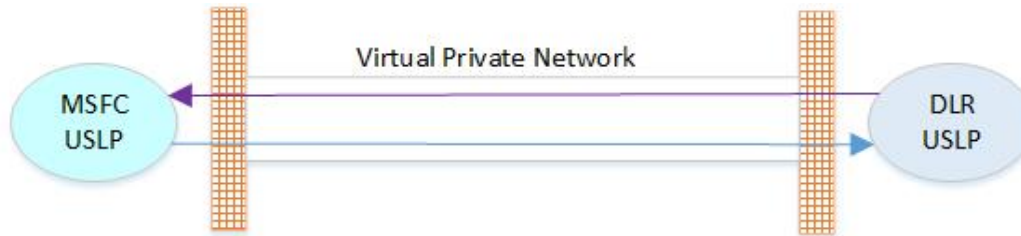


## Software configuration

- DLR
  - LINUX based on SLES 12 with 64 bit
  - Executing on VMware virtual server
    - 1 CPU (Intel(R) Xeon(R) CPU E5-2630 v3 @ 2.40GHz)
    - 64-bit Architecture
    - 4 GB RAM
    - Implemented in C++
- MSFC HOSC
  - LINUX based on RHEL7.5 with 64 bit
  - Executing on VMware virtual server
    - 2 x Intel Xeon E5-2680 processor 2.70GHz, 16 Cores
    - 64-bit Architecture
    - 76 GB RAM
- QinetiQ
  - Ubuntu LINUX 14.04.02
  - Python version running is 2.7
  - Desktop
    - Xeon E3-1200 v3/ 4th Gen core processor.
    - Intel 8 series C220 chipset
    - Nvidia GM107 GPU (GTX 750 Ti)

- Test goal is non-performance related
  - Functional testing
  - Basic framework
- Ten test cases were defined
  - 2 test cases for fixed length frames in a bi-directional fashion
  - 2 test cases for variable length frames in a bi-directional fashion
  - 2 test cases to exercise COP-1 function
  - 2 test cases to exercise SDLS function
  - 2 test cases to exercise C&S signaling
- Most test cases exercised with frame exchange over UPD/VPN
- All Protocol Implementation Conformance Statement (PICS) were allocated to test cases

- Test cases 0-3 are considered basic and exercise fundamental USLP capabilities to include creation of Protocol Data Units (PDU) with their constituent parts.
  - Construction rules are exercised in concert with manage parameters.
  - Test configuration is shown in the following figure where each USLP implementation transfers a PDU via UDP.



- Packet contents are human readable in all instances to enable quick verification. The following example is typical.

Example: 00 U N C 00 0d O P Y R I G H T A B L E 0 0

- Test Cases 0-3 (TC 0-3) are considered basic and exercise fundamental USLP capabilities to include creation of Protocol Data Units (PDU) with their constituent parts.
  - Each sender sends USLP frames to their counterpart independently in a simplex fashion.
    - Test Cases 0 and 1 are for fixed length frames.
    - Test Cases 2-3 are for variable length frames.
    - TC 0-3 omit optional features.
  - Logs are retrieved for analysis after each test
  - DLR, MSFC, and Qinetiq participated in Test Cases 0-3



- Test Cases 2 and 3 were repeated for larger frame sizes and were conducted by file transfer to avoid out of order packets
  - Nine maximum fixed length frames were sent with a single Service Data Unit (SDU) per frame
    - three with CCSDS space packets
    - three with MAPA SDUs
    - three with Octet streams
  - The use of Octet streams necessitates the use of variable construction rules
  - A predictable data field data was used to help verify length and content.

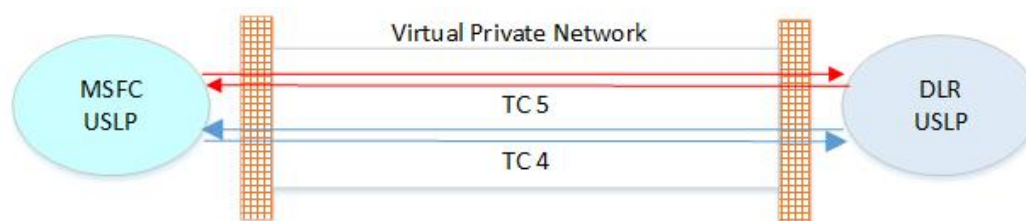
# TC 0-3 Basic Test Cases

name	Description	Direction	purpose	requirements
TC0	Fixed frames verifying all the parameters. Defines the service data units and parameters that compose them. Exercises use of service primitives and USLP Protocol Data Unit,	MSFC>DLR or Qinetiq		
	USLP Protocol Data Units		Frame construction	3.2.2-3.2.7, 4.1.1-4.1.6, 4.2.9, 4.3.9, Table 5-1, Table 5-5
	MAP Packet Construction		MAP Packet constructin	3.3.2.2-3.3.2.9, 3.3.3.2-3.3.3.4, 4.2.2, 4.2.5, 4.3.2, 4.3.5, Table 5-4
	MAPA Packet Construction		MAPA Packet constructin	3.4.2.2-3.4.2.7, 3.4.3.2-3.4.3.4, 4.2.3, 4.3.3
	MC_OCF Service Parameters		MCF inserted fixed length transfer	3.6.2.2-3.6.2.4, 3.6.3.2-3.6.3.3
	VCF Service Parameters		Virtual Channel Frame	3.7.2.2-3.7.2.4, 3.7.3.2-3.7.3.3, 4.2.6, 4.2.7, 4.3.6, 4.3.7, Table 5-3
	MCF Service Parameters		Master Channel Frame	3.8.2.2-3.8.2.4, 3.8.3.2-3.8.3.3, 4.2.8, Table 5-2
	Insert Service Parameters			3.9.2.2-3.9.2.4, 3.9.3.2-3.9.3.3
TC1	Fixed frames verifying all the parameters. Defines the service data units and parameters that compose them. Exercises use of service primitives and USLP Protocol Data Unit,	MSFC>DLR or Qinetiq		
	USLP Protocol Data Units		Frame construction	3.2.2-3.2.7, 4.1.1-4.1.6, 4.2.9, 4.3.9, Table 5-1, Table 5-5
	MAP Packet Construction		MAP Packet constructin	3.3.2.2-3.3.2.9, 3.3.3.2-3.3.3.4, 4.2.2, 4.2.5, 4.3.2, 4.3.5, Table 5-4
	MAPA Packet Construction		MAPA Packet constructin	3.4.2.2-3.4.2.7, 3.4.3.2-3.4.3.4, 4.2.3, 4.3.3
	MC_OCF Service Parameters		MCF inserted fixed length transfer	3.6.2.2-3.6.2.4, 3.6.3.2-3.6.3.3
	VCF Service Parameters		Virtual Channel Frame	3.7.2.2-3.7.2.4, 3.7.3.2-3.7.3.3, 4.2.6, 4.2.7, 4.3.6, 4.3.7, Table 5-3
	MCF Service Parameters		Master Channel Frame	3.8.2.2-3.8.2.4, 3.8.3.2-3.8.3.3, 4.2.8, Table 5-2
	Insert Service Parameters			3.9.2.2-3.9.2.4, 3.9.3.2-3.9.3.3

# TC 0-3 Basic Test Cases

name	Description	Direction	purpose	requirements
TC2	Variable frames verifying all the parameters. Defines the service data units and parameters that compose them. Exercises use of service primitives and USLP Protocol Data Unit,	DLR or Qinetiq > MSFC		
	USLP Protocol Data Units		Frame construction	3.2.2-3.2.7, 4.1.1-4.1.6, 4.2.9, 4.3.9, Table 5-1, Table 5-5
	MAP Packet Construction		MAP Packet constructin	3.3.2.2-3.3.2.9, 3.3.3.2-3.3.3.4, 4.2.2, 4.2.5, 4.3.2, 4.3.5, Table 5-4
	MAPA Packet Construction		MAPA Packet constructin	3.4.2.2-3.4.2.7, 3.4.3.2-3.4.3.4, 4.2.3, 4.3.3
	MAP Octet Stream Service		Serial Octet stream transfer	3.5.2.2-3.5.2.6, 3.5.3.2-3.5.3.3, 4.2.4, 4.3.4
	MC_OCF Service Parameters		MCF inserted variable length transfer	3.6.2.2-3.6.2.4, 3.6.3.2-3.6.3.3
	VCF Service Parameters		Virtual Channel Frame	3.7.2.2-3.7.2.4, 3.7.3.2-3.7.3.3, 4.2.6, 4.2.7, 4.3.6, 4.3.7, Table 5-3
	MCF Service Parameters		Master Channel Frame	3.8.2.2-3.8.2.4, 3.8.3.2-3.8.3.3, 4.2.8, Table 5-2
	Insert Service Parameters			3.9.2.2-3.9.2.4, 3.9.3.2-3.9.3.3
TC3	Variable frames verifying all the parameters. Defines the service data units and parameters that compose them. Exercises use of service primitives and USLP Protocol Data Unit,	DLR or Qinetiq >MSFC		
	USLP Protocol Data Units		Frame construction	3.2.2-3.2.7, 4.1.1-4.1.6, 4.2.9, 4.3.9, Table 5-1, Table 5-5
	MAP Packet Construction		MAP Packet constructin	3.3.2.2-3.3.2.9, 3.3.3.2-3.3.3.4, 4.2.2, 4.2.5, 4.3.2, 4.3.5, Table 5-4
	MAPA Packet Construction		MAPA Packet constructin	3.4.2.2-3.4.2.7, 3.4.3.2-3.4.3.4, 4.2.3, 4.3.3
	MAP Octet Stream Service		Serial Octet stream transfer	3.5.2.2-3.5.2.6, 3.5.3.2-3.5.3.3, 4.2.4, 4.3.4
	MC_OCF Service Parameters		MCF inserted variable length transfer	3.6.2.2-3.6.2.4, 3.6.3.2-3.6.3.3
	VCF Service Parameters		Virtual Channel Frame	3.7.2.2-3.7.2.4, 3.7.3.2-3.7.3.3, 4.2.6, 4.2.7, 4.3.6, 4.3.7, Table 5-3
	MCF Service Parameters		Master Channel Frame	3.8.2.2-3.8.2.4, 3.8.3.2-3.8.3.3, 4.2.8, Table 5-2
	Insert Service Parameters			3.9.2.2-3.9.2.4, 3.9.3.2-3.9.3.3

- Test cases 4-5 exercise support for Command Operations Procedures (COP) in USLP
- Each test case requires two-way communication
- Test case 4 has Qinetiq as the originator of the exchange and test case 5 originates with MSF
- In each case, the responder must reply in a simplex fashion with associated acknowledgements
  - UDP packet exchange
  - File based packet exchange
- Construction rules are exercised in concert with managed parameters
- A Test configuration is shown in the following figure where the originator transfer a file of representative frames



- Initial testing sent was with Qinetiq sending Frame Operating Procedure (FOP) Frame Data Units (FDUs) and MSFC responding with Command Link Control Word (CLCW)
  - Injected error was only on the MSFC side
  - MSFC acted as the Frame Acceptance and Reporting Mechanism (FARM)
  - 5 good frames were received and 2 frames dropped
- When MSFC acted as the FOP
  - 5 good frames were sent before a frame was dropped frame
  - Qinetiq acted as the FARM
  - 5 good frames were received and 1 frames dropped
- Aggregation of data was left to each test team
  - MSFC would send one line of data per FDU
  - Qinetiq would send multiple lines of data per FDU
- FDUs were composed of the Rhyme of the Ancient Mariner
- MSFC and Qinetiq participated in Test Cases 4-5

# TC 4-5 COP TEST CASES



name	Description	Direction	purpose	requirements
TC4	Exercises use of COP in USLP	MSFC>Qinetiq		
			USLP Protocol Data Units	3.2.2 -3.2.7, 4.1.1-4.1.6, 4.2.9, 4.3.9, Table 5-1, Table 5-5
			COPs Management Service Parameters	3.10.2.2.1-3.10.2.7
			COPs Management Service Primitives	3.10.3.2-3.10.3.4
			Managed Parameters for a Virtual Channel	Table 5-3,
TC5	Exercises use of COP in USLP	Qinetiq > MSFC		
			USLP Protocol Data Units	3.2.2 -3.2.7, 4.1.1-4.1.6, 4.2.9, 4.3.9, Table 5-1, Table 5-5
			COPs Management Service Parameters	3.10.2.2.1-3.10.2.7
			COPs Management Service Primitives	3.10.3.2-3.10.3.4
			Managed Parameters for a Virtual Channel	Table 5-3,

- Test cases 6-7 exercise support for SDLS in USLP.
  - Each test case requires two-way communication
  - Test case 6 used MSFC as the originator of normal USLP frame
  - Test case 7 had MSFC as the recipient
  - Construction rules are exercised in concert with managed parameters.
- Test configuration is shown in the following figure where each USLP implementation transfers a PDU via UDP.

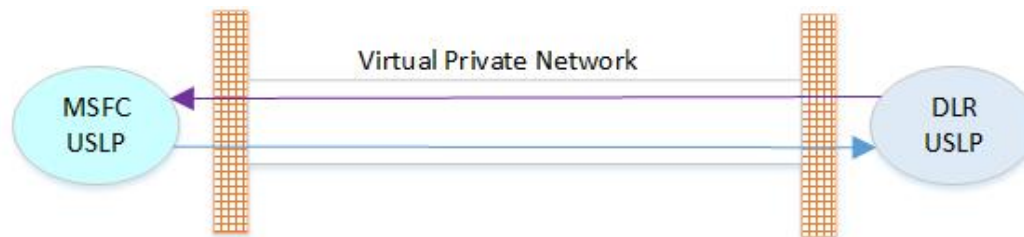


- Test cases 6-7 were combined with TC 0-3
  - Test case parameters were identical to TC 0-3 with the addition of security headers and trailers
  - These were included in all VCIDs.
- Reception was verified in all cases.
  - Security Header – present in all VCIDs, length 3 “:h;”
  - Security Trailer – present in all VCIDs, length 8 “[-tral~]”
  - DLR, MSFC, and Qinetiq participated in Test Cases 6-7



TC6	Exercises use of SDLS in USLP	MSFC>DLR and Qinetiq		
			USLP Protocol Data Units	3.2.2 -3.2.7, 4.1.1-4.1.6, 4.2.9, 4.3.9, Table 5-1, Table 5-5, Table 6-1
			Header, Trailer, TFDF, OCF	6.3.4, 6.3.6, 6.3.5.2, 6.3.7.2,
			FECF, Packet Processing, Octet Stream Processing, VC Gen,	6.3.8.2, 6.4.2.2, 6.4.3.2, 6.4.4.3, 6.4.4.2
			Error reporting, Packet extraction, VC reception	6.5.2.2, 6.5.3.2, 6.5.4.2, 6.5.5.2, 6.5.5.3
			VC Demultiplexing	6.5.6.2
TC7	Exercises use of SDLS in USLP	DLR and Qinetiq>MSFC		
			USLP Protocol Data Units	3.2.2 -3.2.7, 4.1.1-4.1.6, 4.2.9, 4.3.9, Table 5-1, Table 5-5, Table 6-1
			Header, Trailer, TFDF, OCF	6.3.4, 6.3.6, 6.3.5.2, 6.3.7.2,
			FECF, Packet Processing, Octet Stream Processing, VC Gen,	6.3.8.2, 6.4.4.2, 6.4.4.3, 6.4.4.2,
			Error reporting, Packet extraction, VC reception	6.5.2.2, 6.5.3.2, 6.5.4.2, 6.5.5.2, 6.5.5.3
			VC Demultiplexing	6.5.6.2

- Test cases 8 and 9 exercised support for the Prox-1 C&S sublayer interface in USLP
  - Each test case requires one-way communication
  - Test case 8 used MSFC as the receiver of normal USLP frames
  - Test case 9 had DLR as the recipient
- Each test case requires two passes through a file of 100 USLP frames using a prox-1 stub
- A Test configuration is shown in the following figure where the originator transfers a file of representative frames



- Test cases 8 and 9 exercised support for the Prox-1 C&S sublayer interface in USLP
  - Each test case requires one-way communication
  - Test case 8 used MSFC as the receive of normal USLP frames
  - Test case 9 had DLR as the recipient of normal USLP frames
  
- For the first pass the stub scanned the file to find sync markers with the Quality indicator flag set to “false”
  - When a marker was found, the stub delivered the subsequent USLP frame to the USLP receiver for processing
  - The frames length was determined by the USLP frame length octets
  - The prox-1 stub skipped any idle octets and continued scanning for sync markers to repeat the process until the file was completely processed

- For the second pass the stub scanned the file to find sync markers with the Quality indicator flag set to “true” for every tenth frame
  - The frames length was determined by the USLP frame length octets
  - Erroneous frames were intentionally dropped instead of being delivered to USLP
  - Scanning to find sync markers was then resumed
  - Valid ULSP frames were delivered to the USLP receiver for processing
  - The prox-1 stub skipped any idle octets and continued scanning for sync markers to repeat the process until the file was completely processed
  
- The number of USLP frames processed was 90 with only the MC\_OCF flag indicating that there were frame counter errors
  - DLR and MSFC participated in Test Cases 8-9

# Forward actions

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- None

- Three independent agencies participated in prototype testing of the Unified Space Data Link Protocol as defined in CCSDS 732x0r3.
- Test planning and reporting have been documented and provided to the area manager.
- During the testing, USLP transfer frames of the various types were produced by two or more different agencies.
- The ability to read/process messages was demonstrated based on the diversity of agencies' able to read/write transfer frames with diverse options and positive test results.

**BACKUP**

# PICS Performa summary



Annex A REQUIREMENTS LIST	MSFC		DLR or Qinetiq	
Table A-1: USLP Service Data Units	6	100%	6	100%
Table A-2: Service Parameters				
MAP Packet Service Parameters	8	100%	8	100.00%
MAPA Packet Service Parameters	6	100%	6	100.00%
MAP Octet Stream Service Parameters	5	100%	5	100.00%
MC_OCF Service Parameters	3	100%	3	100.00%
VCF Service Parameters	3	100%	3	100.00%
MCF Service Parameters	3	100%	3	100.00%
Insert Service Parameters	3	100%	3	100.00%
COPs Management Service Parameters	7	100%	0	0.00%
Table A-3: Service Primitives				
MAP Packet Service Primitives	3	100.00%	3	100.00%
MAPA Service Primitives	3	100.00%	3	100.00%
MAP Octet Stream Service Primitives	2	100.00%	2	100.00%
MC_OCF Service Primitives	2	100.00%	2	100.00%
VCF Service Primitives	2	100.00%	2	100.00%
MCF Service Primitives	2	100.00%	2	100.00%
Insert Service Primitives	2	100.00%	2	100.00%
COPs Management Service Primitives	3	100.00%	0	0.00%
	63	100.00%	53	84.13%
Annex A REQUIREMENTS LIST	MSFC		DLR	
Table A-4: USLP Protocol Data Unit	6	100.00%	6	100.00%
Table A-5: Protocol Procedures	16	100.00%	16	100.00%
Table A-6: Management Parameters				
Parameters for a Physical Channel	12	100.00%	12	100.00%
Managed Parameters for a Master Channel	4	100.00%	4	100.00%
Managed Parameters for a Virtual Channel	16	100.00%	13	81.25%
Managed Parameters for a MAP Channel	3	100.00%	3	100.00%
Managed Parameters for a Packet Transfer	3	100.00%	3	100.00%
Table A-7: Protocol Specification with SDLS Option	14	100.00%	14	100.00%
Table A-8: Additional Managed Parameters with SDLS Option	4	100.00%	4	100.00%
	78		75	
Table A-9: Frame Error Control Field Coding Procedures	4	100.00%	4	100.00%
Total based on 145 total PICS count	145	100.00%	132	91.03%



# Rhyme of the Ancient Mariner



First 20 lines of the *Rhyme of the Ancient Mariner* by Samuel Taylor Coleridge

It is an ancient Mariner,  
And he stoppeth one of three.  
'By thy long grey beard and glittering eye,  
Now wherefore stopp'st thou me?

The Bridegroom's doors are opened wide,  
And I am next of kin;  
The guests are met, the feast is set:  
May'st hear the merry din.'

He holds him with his skinny hand,  
'There was a ship,' quoth he.  
'Hold off! unhand me, grey-beard loon!  
Eftsoons his hand dropt he.

He holds him with his glittering eye—  
The Wedding-Guest stood still,  
And listens like a three years' child:  
The Mariner hath his will.

The Wedding-Guest sat on a stone:  
He cannot choose but hear;  
And thus spake on that ancient man,  
The bright-eyed Mariner.