UNIVERSITY OF DUNDEE
Department of Applied Computing

SPACE SYSTEMS RESEARCH GROUP

CCSDS
Spacecraft Onboard Interface Services

SpaceWire Working Group Meeting

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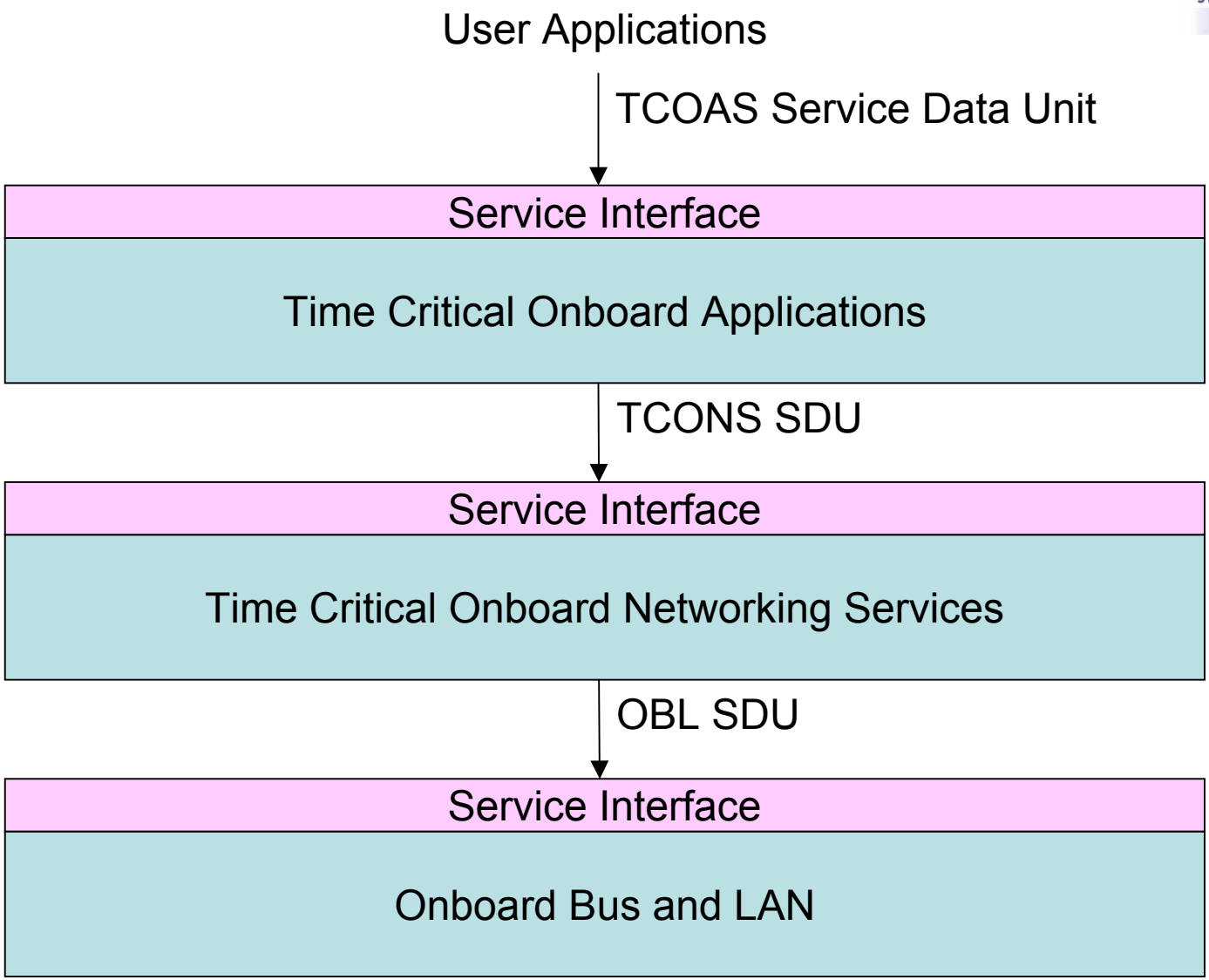
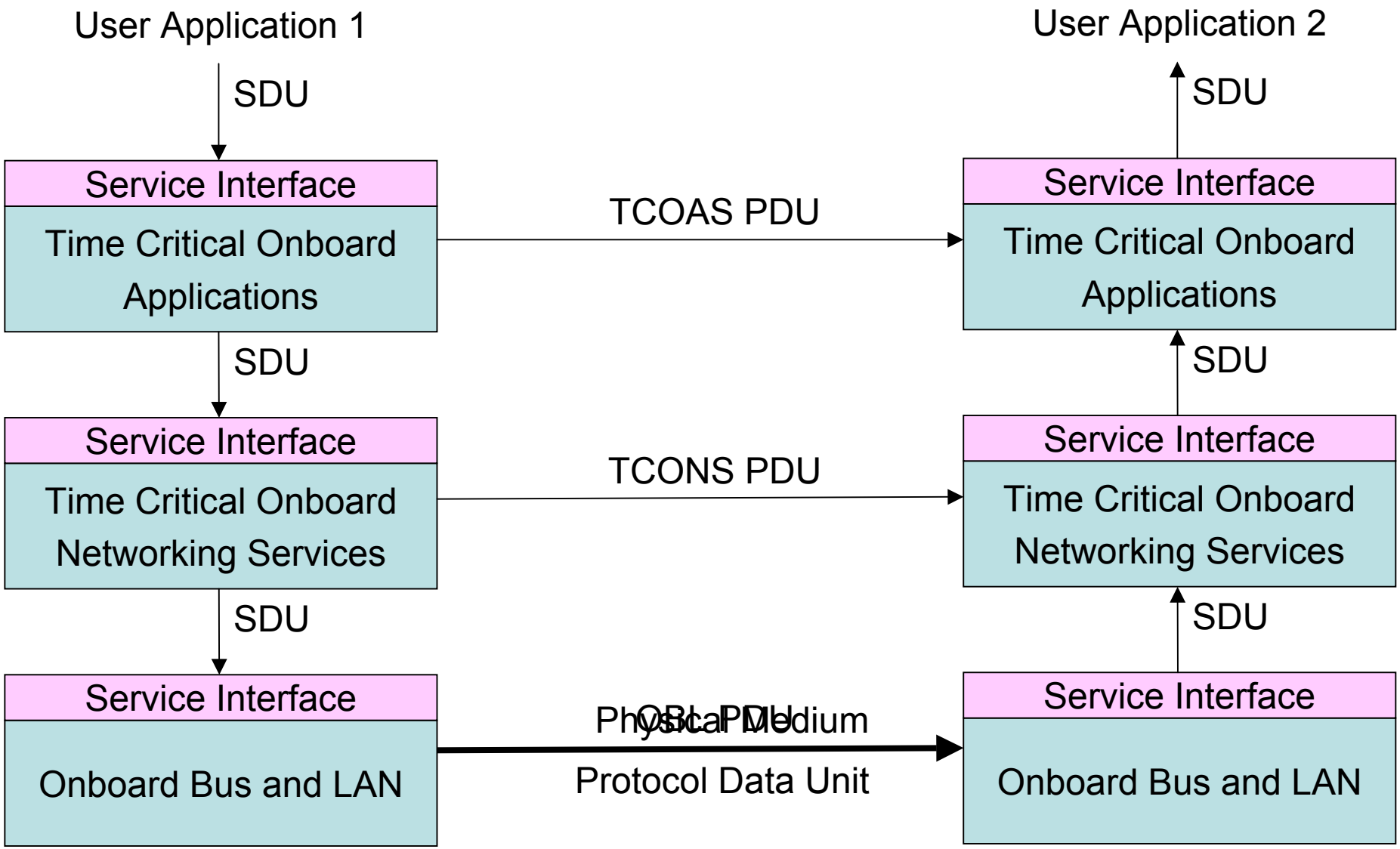
Aims of SOIS

- Spacecraft Onboard Interface Services
- Standardise
  - Hardware
  - Software
- Encourage reuse
- Reduce cost
- Improve reliability
- More science per euro/dollar/yen…

SOIS Structure



SOIS Structure



TCONS Aims

- Common networking services
- Across several underlying buses/sub-networks
- Carry multiple network/transport/application protocols
- Time critical services
- Consistent quality of service paradigm

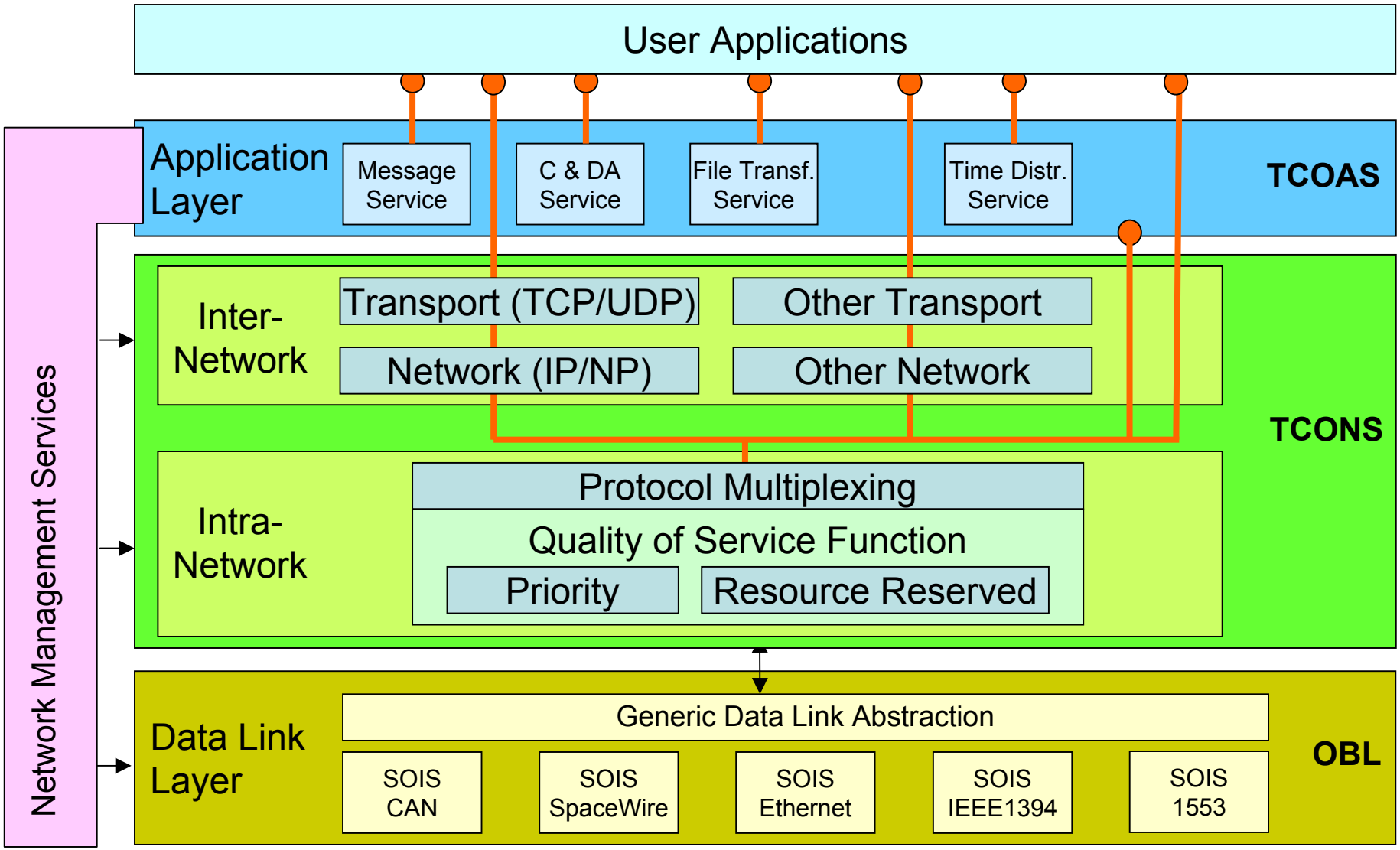
OBL Aims

- Define the functions needed to implement TCONS
- On each bus/sub-network
- Generic data link abstraction
- Specific definitions for specific buses/sub-networks
  - E.g. SpaceWire

TCONS/OBL Working Group

- TCONS
  - Chair: Steve Parkes
  - Deputy Chair: Jane Marquart
- OBL
  - Chair: Rick Schnurr
  - Deputy Chair: Chris Plummer
- Members
  - Greg Menke
  - Rick Schnurr
  - Max Ciccone
  - Dai Stanton
  - Maxime Perotin

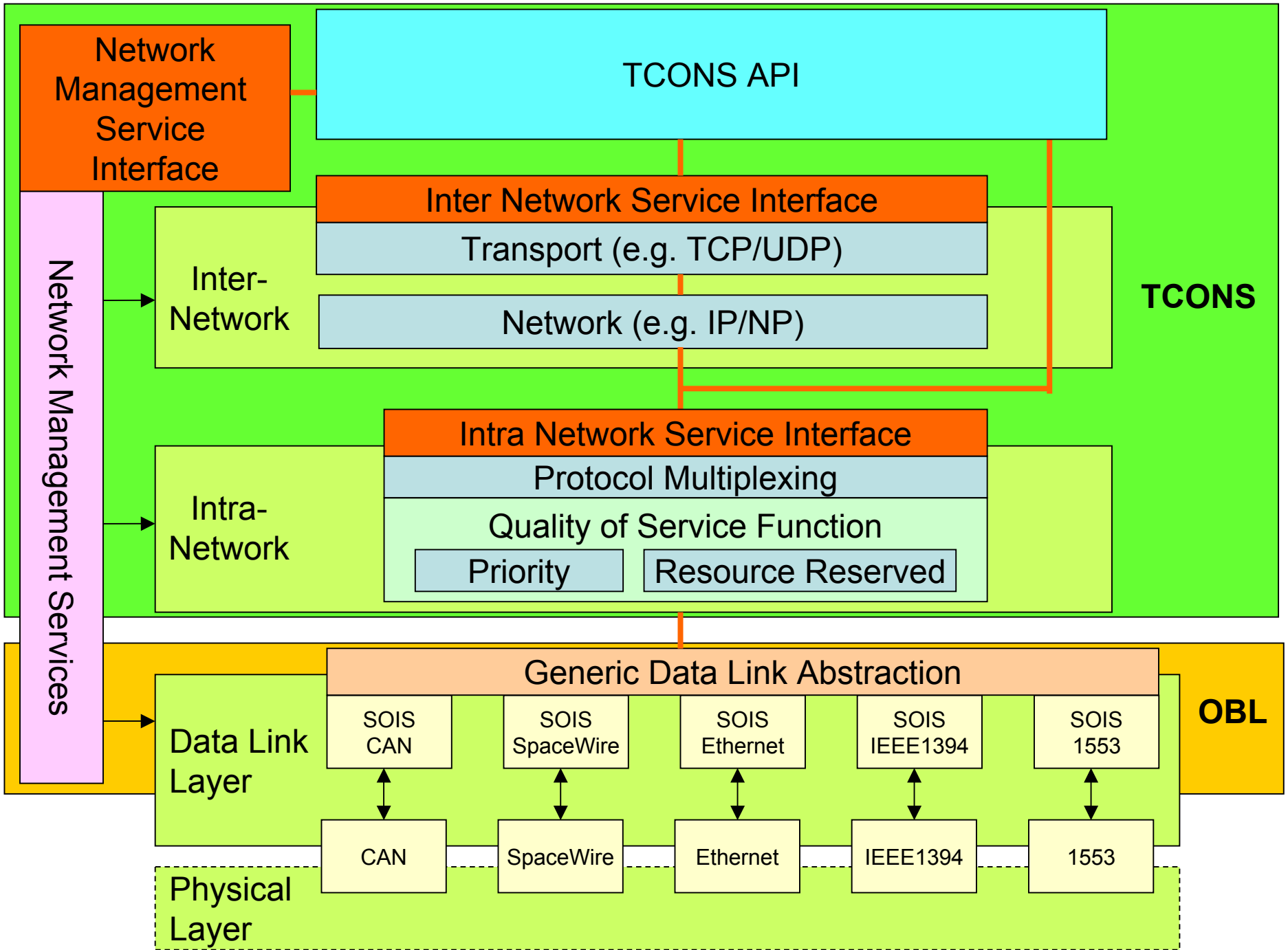
SOIS Protocol Stack



TCOAS

- Provides common onboard application services
- Message passing service
- Time-distribution service
- Command and data acquisition service
- Possible file transfer service
  - Current thinking is that this is not needed

- Network management is a common application but will be defined by TCONS/OBL

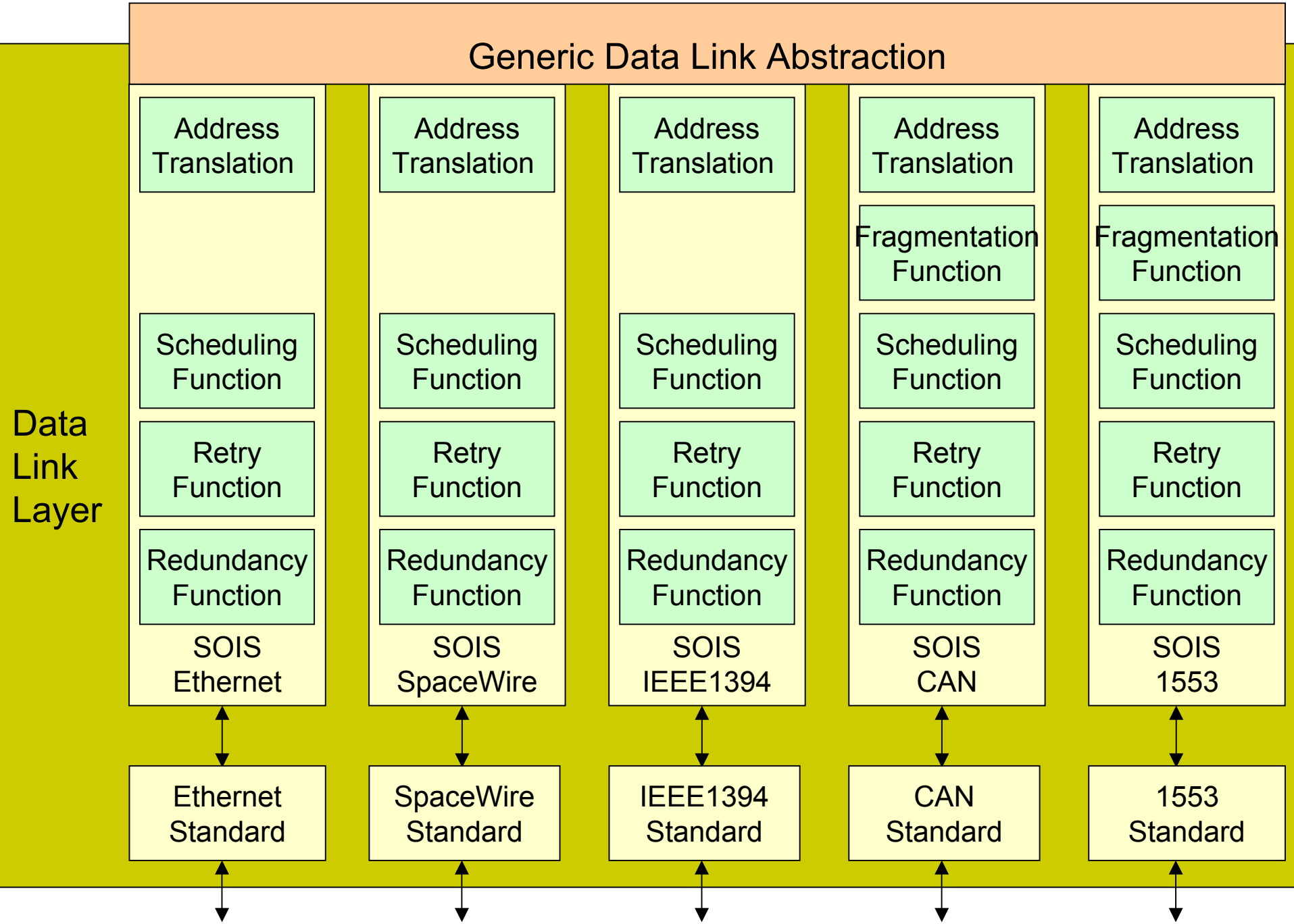

Network Management Service Interface
TCONS API
Inter Network Service Interface
Transport (e.g. TCP/UDP)
Inter-Network
Network (e.g. IP/NP)
TCONS
Intra Network Service Interface
Protocol Multiplexing
Intra-Network
Quality of Service Function
Priority
Resource Reserved
Network Management Services
Generic Data Link Abstraction
SOIS CAN
SOIS SpaceWire
SOIS Ethernet
SOIS IEEE1394
SOIS 1553
OBL
Data Link Layer
CAN
SpaceWire
Ethernet
IEEE1394
1553
Physical Layer

TCONS – Inter-Network

- Multiplexing of higher level protocols
  - May be mapped to SpaceWire Protocol ID
- Quality of service
  - QoS tag used to specify what class of traffic a SDU is
  - QoS tag defines how SDU will be treated
  - as it passes through the onboard network
- Quality of service examples
  - Priority
  - Bandwidth reservation
  - Scheduled delivery

Traffic Classes

- Traffic Class;
  - A category of traffic on a sub-network distinguished by quality of service
  - For example:
    - Best effort with priority
    - Guaranteed Delivery with priority
    - Bandwidth reservation
    - Scheduled delivery
    - etc
  - Specify traffic class for each SDU via service interface
  - Map SDU into traffic classes


Generic Data Link Abstraction
Data Link Layer
Address Translation
Fragmentation Function
Scheduling Function
Retry Function
Redundancy Function
SOIS Ethernet
SOIS SpaceWire
SOIS IEEE1394
SOIS CAN
SOIS 1553
Ethernet Standard
SpaceWire Standard
IEEE1394 Standard
CAN Standard
1553 Standard

Redundancy

- Redundancy models:
  - equivalent data links
  - provide alternative paths
  - from a source end-point to a destination end-point
  - on a single sub-network.
- Equivalent data links may be used in one of three ways:
  - Sending data over both paths at the same time.
  - Sending over the prime link and then if there is a failure using the redundant link (Often used for MIL-STD-1553 bus).
  - Sending over either link, then if failure of one link all traffic goes over the remaining link.
- Autonomous switching between equivalent data links supported.
- Controlled using management parameters associated with a traffic class.
- System management policy might dictate a uniform redundancy policy which applications must use.
- The link redundancy function is bus/sub-network specific.

Retry

- Retry function provides mechanism for
  - Resending PDUs
  - Not received correctly at the other end of the data link.
- When the source sends a PDU it starts a timer.
- When PDU arrives at the destination an acknowledgement is returned to the source.
- If source does not receive acknowledgement before timer times-out
  - Then PDU is assumed not to have arrived at the destination
  - Source resends the PDU.
- If multiple copies of the same PDU arrive at the destination
  - Then any duplicates are discarded.
- Currently LLC is being investigated as a basis for the SOIS retry function.
- Link Redundancy is Bus/sub-network specific.

Scheduling

- Delivery of PDUs according to a predefined schedule.
- May be used
  - to support deterministic data delivery
  - to reserve bus/sub-network bandwidth
- Scheduling function splits up the bandwidth on a bus/sub-network using time division multiplexing.
- A number of equal duration time-slices are determined.
- During a time-slice one end-point can send one or more PDUs
  - provided that they do not exceed the duration of the time-slot.
- If retry is to be supported in a particular time-slot
  - then the PDU length must be short enough to allow the maximum number of retries within a single slot.
- Time-slots repeat cyclically with a repetition interval known as an epoch.
- Knowledge about the communication schedule held in each end-point
- So that they know when (i.e. in which time-slot) they are allowed to transmit data.
- If a bus/sub-network supports broadcast
  - the PDU sent in one slot many be received by one, several or all end-points on the sub-network.

Fragmentation

- Fragmentation is needed
  - If the underlying bus/sub-network cannot support maximum PDU size
  - in a single packet on the bus/sub-network
  - Or if the largest PDU will not fit in the allocated time slots.
- Data link's responsibility
  - To fragment PDUs if necessary
  - To reassemble them at the other end of the data link
  - To reform the original PDUs before they are passed up to the inter-network layer.
- Buses/sub-networks that can support the maximum PDU size in a single packet need not do fragmentation.
- Assuming the maximum PDU is compatible with schedule table requirements.
- The Fragmentation function is Bus/sub-network specific.

Address Translation

- In general each OBL has its own private address space.
- SOIS will support two classes of OBL
  - Non-route through OBL
    - IP source and destination addresses are mapped onto an OBL address space
    - Knowledge of the original IP address is lost,
  - Route through OBL
    - Original IP source and destination address is either transmitted
    - Or mapped in a recoverable way to the OBL address space.
- Address translation translates between network address and OBL address space.
- The Address translation function is Bus/sub-network specific.

Current Status

- TCONS/OBL architecture defined
- QoS and Traffic class document being written
- TCONS service interfaces
  - Inter-network being defined
  - Intra-network being defined
- OBL
  - Generic data link interface being defined
  - Concurrent work on mapping
    - To SpaceWire
    - To Ethernet

Planned Work

- Plan to have
  - Architecture white paper
  - Quality of Service white paper
  - Draft intra-network service red book
  - Draft inter-network service red book
- By September meeting in Atlanta
- Meeting will consolidate this work
- Then focus on network management
- And example bus mappings
  - SpaceWire
  - Ethernet
  - Others